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Symposium on Maxillofacial Surgery

Editorial

PATIENTS requiring maxillofacial surgery either because of traumatic injuries, congenital deformities or facial malignancies, with their associated postoperative reconstructive problems, should expect the surgeon undertaking this assignment to be skilled and proficient in all basic problems necessary to attain a satisfactory functional as well as esthetic result.

The training necessary to become adept in the management of maxillofacial problems demands that the surgeon have a basic and working knowledge and understanding of many fields including those of plastic surgery, general surgery, dentistry (including orthodontics and prosthodontics), neurosurgery, otolaryngology and radiology. There are some surgeons who have spent many years in formal and clinical training encompassing these fields of medicine and dentistry, and who limit their scope of surgery to this particular facet, namely, maxillofacial surgery. As one might expect, their concentrated efforts in a more limited area have given them considerable basic information and coordinating ability in the management of maxillofacial problems. These surgeons have scattered alliances with various specialty and general surgical groups, and their recognition as a highly specialized branch of surgery has been accepted in many large institutions. It would seem that those surgeons desiring limitation of their work to this one area, following completion of their basic training, should be given this recognition. The older maxillofacial surgeons, by virtue of their accomplishments in this field, are serving as a nucleus for further training and encouragement of younger men in their years of training. During its original inception, the specialty of plastic surgery encompassed this field because of the interest of many of the founder members who subsequently carefully nurtured this portion of the specialty. The incorporation of this particular specially trained group on their own merit will enhance this already flourishing specialty. This expansion of training in maxillofacial surgery will inevitably result in finer care of the patient with maxillofacial problems.

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Partial Reconstruction of the Nose

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THE loss of the alar or the lateral cartilagenous portions of the nose, when it is possible to view directly the mucous membrane lining of the septum and even the turbinates, is unquestionably a disfigurement that should be corrected regardless of age. This catastrophe occurs as a result of trauma in some instances and postsurgically in others, following radical excision of a neoplastic lesion. Infection with sloughing has also been recognized as being an inciting cause for loss of tissue in this area. The resulting defect is so repulsive in appearance that regardless of the patient's age surgical rehabilitation is in order.

Down through the years our predecessors have attacked this problem in many ways, and have handed down multiple ingenious approaches for the correction of this particular defect. Their contributions have led us to employ such flaps as the contiguous flap from the nasolabial region, distant flaps from the forehead and the necklace pedicle from the neck. Their employment, although improving the picture considerably, has left the patient with additional disfigurement as a result of the donor sites and has resulted in multiple-staged procedures. The end result also leaves much to be desired, and although we might congratulate ourselves on a finished technic and find ourselves pleased with the end result, certainly an esthetic evaluation will bring out many undesirable features. Consequently, this is a problem that warrants further consideration.

Case reports, by their very nature, supply facts which are generally unusual. For the most part, aside from the dramatic import of the subject material, they rarely contribute additional data that might be employed as a basis of principle. Also, scientifically speaking, principles should not be predicated on a single case. However, I believe this is an illustration that might be the exception to the rule, and thus I enthusiastically present this mode of approach in the management of a common problem with the hope that it might contribute something lastingly beneficial, and at least stimulate further thought on the principle propounded, perhaps revealing further indications for its application.

The technic evolved was inadvertently resorted to, dictated entirely by circumstances. It almost abrogates certain accepted principles of plastic surgery, consequently it was performed with a feeling of trepidation. Nevertheless, following the demands of the situation, a single-stage procedure for reconstruction of the alar and the entire lateral cartilagenous portion of the nose was used, which allowed the patient to be socially presentable within four weeks' time. It also turned out to be cosmetically superior to any mode of management known to me or, as far as I am aware, publicized in the journals to this date, which is astonishing in view of the simplicity of the procedure. Simultaneously, a disfiguring donor site has been automatically eliminated, and the final picture presents a controlled placement and contouring of the missing portion of the nose.

I find that all requisites have been complied with, namely, the technic provides a smooth intranasal lining and symmetry in the width and placement of the alar; it automatically results in a shape and contour so earnestly desired in the reconstruction of an alar; it provides a disguised donor site, a better color match than generally obtained, a curve to the alar, including the buccal alar crease, a flare to the nostril rather than the usual inward roll, and an even distribution of tissue which is so much in contrast with the usual bulbous, "putty-like" appearance of the routinely employed pedicle or flap reconstruction technics used to date.

FIG. 1. Appearance of patient approximately six weeks after injury. Alar and goodly portion of lateral cartilage lost.

CASE REPORT

Following is the case history of the patient on whom this procedure was performed.

As a result of an automobile accident, an eighteen year old girl was brought into the hospital with an admission diagnosis of concussion, multiple massive facial lacerations and a complete loss of the right side of the nose. The emergency treatment rendered was that of plastic repair of the lacerations, with the wound edges of the lost portion of the nose being sutured, mucosa to skin, and no thought or attempt being made for immediate reconstruction in view of the general condition of the patient.

Following an uneventful convalescence, the patient, of the type generally referred to as the "belle of the ball," presented with a ghastly appearance due to the absent portions of the nose. Treatment planning was undertaken and all approaches were analyzed as to their pertinent applicability. The large laceration, which originally extended from the base of the nose along the entire length of the nasolabial crease, subsequently healed into a scar which produced an exaggerated crease in the area of the nasolabial fold. In the course of evaluating this scar and its subsequent treatment, it was believed it would be feasible in every respect to attempt some fashion of reconstruction employing the nasolabial flap. Since the scar already encroached in part upon the "apple portion" of the cheek, it was believed that it would be permissable to consider a cheek flap in the repair of the absent portion of the nose. (Fig. 1.)

The patient was subsequently brought to surgery and a large flap was outlined by scalpel. A "seasoning" procedure was contemplated but, progressing cautiously and studying circulation, the flap was gradually raised and elevated by a small hook retractor to a 90 degree angle with the base. Curiosity prompted a vascular tone check by turning the flap an additional 90 degrees until a total of 180 degrees' bend was present with the flap falling easily into the defect of the nose. Free oozing from the tip encouraged the temporary placement of the flap in its intended position. The flap was viewed for a period of exactly ten minutes with no noticeable change in color. The necessity for a delay stage was questioned and, after a further ten minutes of vacillation, it was finally decided to insert the flap to supply the missing tissue.

FIG. 2. Six days postoperatively, showing size of flap, donor site and full-thickness skin graft coverage of flap.

FIG. 3. Appearance four and a half months postoperatively.

This was done by splitting the wound edges of the defect rather than denuding by excision, and the flap was inserted. Using No. 5-0 Atraumatic® silk, the flap was sutured into place and the nose immediately assumed an appearance approaching normalcy. A full-thickness skin graft was obtained from the supraclavicular area, was quickly applied on the raw, exposed, external surface of the newly created nostril and sutured into place with No. 6-0 eye silk sutures. The donor site in the cheek was then undermined and was noted to fall, with undue tension, into the area of the nasalabial crease. The skin graft was left exposed to permit direct observation.

A continuous watch was maintained over the patient to avoid any trauma or disturbance to the pedicle until she had fully reacted. Financial circumstances permitted a nurse to be employed for the hours of 11:00 P.M. to 7:00 A.M. for seven days, solely to guard against the patient touching or rolling upon the flap while asleep. (Fig. 2.)

Following the patient's discharge from the hospital ten days later, a regular follow-up examination was made for a period of six months, with every visit indicating further improvement in appearance. The other scars have been revised on occasion but only one procedure has been dedicated to the reconstruction of the missing portion of the nose. The smooth inner lining of the nose has caused the patient no difficulty regarding cleanliness or irritation, as is sometimes seen on the wrinkled intranasal linings from skin grafts frequently used, and the color is, to our way of thinking, much better in appearance than that seen in the darkening pedicle flaps previously employed. The donor site has healed exquisitely with only a line scar noted. The width of the nostrils is identical, as is the placement of the alars in a superior and inferior position. The crease, naturally existing between the undisturbed alar and the cheek, is present to a near normal degree and the entire portion supplied has a flared appearance. (Fig. 3.)

SUMMARY

In spite of abrogating certain fixed principles, such as extending a donor site out toward the cheek, *per se*, grafting the external portion of the flap rather than the internal aspect of the flap and gambling on the vascular distribution as generally conceived, I believe an approach has been found which is cosmetically superior, with no disfiguring donor site to be complained of, and which is produced in a single-stage procedure rather than a multiple-stage procedure. The advantages to be found with the aforementioned approach lead me to believe that its future employment in partial reconstruction of the nose deserves serious consideration.

Cartilage Block Arthroplasty for the Correction of Temporomandibular Joint Disturbances

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FOUR years ago Hinds and Pleasants presented a paper [9], including a brief review of the history, on the use of blocks of autogenous cartilage in correcting certain deformities of the mandible due to loss of the condyle. During the interim, we have had an opportunity to observe the patients reported on and to utilize the same technic (Fig. 1) in an additional five cases. Conditions in which this procedure have been used are: (1) deformity following loss of condyle, (2) ankylosis and (3) traumatic osteoarthritis with associated pain.

Since 1954 there has been a continued search for improved methods of reconstruction of the temporomandibular joint. Gordon [6] has reported on the use of an ingenious prosthetic condylar head. Entin [4] has reported on the substitution of a metacarpophalangeal joint for a congenitally absent temporomandibular joint. Georgiade et al. [5] in 1957 reported some animal experiments as well as eight clinical cases in which a dermal graft was used for the correction of ankylosis. Henny and Baldridge [7] reported on the use of high condylectomy for the treatment of the persistent painful temporomandibular joint.

In 1953 Dufourmentel and Darcissac [3] reported on 100 cases of ankylosis of the temporomandibular joint. In thirty-three cases cartilage was utilized in the arthroplasty. The authors concluded that (1) cartilage more closely resembled a normal joint than any other interposing material, (2) better postoperative function was obtained when cartilage was used and (3) retrusion deformity could be improved with cartilage.

The problem for which we have found cartilage block arthroplasty to be most suitable is the case in which a deformity of some type, such as open bite, unilateral shift or retrusion, is associated with the loss of the condyle. Of the aforementioned methods, only the prosthetic condyle would be applicable. This is not meant to include deformities due to growth disturbance.

Of the three patients previously reported on, one has died and another has required operation of the opposite condyle. This procedure has also been performed on five additional patients (three procedures were unilateral, and two were bilateral). Two interesting complications have occured in one of these patients.

CASE REPORTS

Follow-up of Previously Reported Cases

CASE 1. G. M., a thirty-five year old white woman, originally presented because of marked retrusion and open bite from loss of the condyle due to rheumatoid arthritis. Cartilage block arthroplasty was performed in two stages on July 6 and

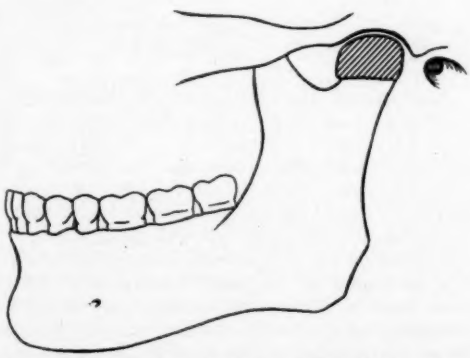


FIG. 1. Line drawing showing cartilage block arthroplasty.

13, 1954. Intermaxillary fixation was maintained for three weeks.

Examination on September 21 revealed the patient's teeth to be in normal class 1 occlusion. Good opening with no limitation was observed. There was bilateral frontal paralysis but this had disappeared by October 5.

This patient died in July 1955. Her mandibular function, however, remained good up until the time of death.

CASE II. J. K., a thirty-seven year old white man, was seen on March 16, 1954, with ankylosis and marked retrusion. Bilateral condylectomy had been performed in August 1953 for ankylosis due to rheumatoid arthritis. In the ensuing six to eight weeks the ankylosis recurred, accompanied by marked retrusion.

On examination it was found that he had difficulty in swallowing and frequently could not control his saliva. The patient was quite obviously undernourished.

On June 9, 1954, the temporomandibular joint areas were explored bilaterally and fibrous adhesions were removed. Kirschner wire was inserted through the symphysis of the mandible, and traction from an overhead frame was applied to the mandible over a period of six weeks. As much as 10 pounds of traction was used at one time. On July 29 cartilage block arthroplasty was performed on the right temporomandibular joint. Two weeks later, on August 13, a similar procedure was performed on the left temporomandibular joint.

Intermaxillary traction was maintained for three additional weeks, at the end of which time it was found that the patient could open his mouth 6 mm. with marked improved occlusion and improved chin position. Opening progressed to a maximum of 15 mm. The patient was able to masticate food without difficulty and gained 21 pounds in the ensuing six weeks.

This patient was last seen on March 2, 1959, and it was noted that he continued to have improved function with satisfactory mastication.

CASE III. E. N., a sixty year old white woman, was first seen on April 12, 1954, with complaints of limited motion of the mandible, shift to the right on opening and pain on opening. This patient had undergone resection of the right condyle two years previously because of pain and limitation of motion due to an arthritis of unexplained etiology.

On September 13 cartilage block arthroplasty was performed on the right temporomandibular joint. Because of the chronic shift, there was considerable pressure in the condylar area, and during the recovery period the cartilage block slipped out of place. The patient was reoperated upon on November 11 and a Kirschner wire was placed through the zygomatic arch to secure the cartilage block. However, this also failed to hold the cartilage securely. Surgery was repeated one week later on November 19, at which time an additional Kirschner wire was inserted to secure the cartilage block. The two Kirschner wires worked much better than one, and the block remained in place. Intermaxillary fixation was maintained for three weeks, with marked improvement in occlusion and function.

The original follow-up on this patient did not extend beyond three months. However, in the subsequent weeks the patient complained again of pain, this time in the left temporomandibular joint area and the right zygomatic area. Repeated occlusal equilibration and diathermy failed to relieve this pain which we believed was probably due to arthritis in the left temporomandibular joint. This was confirmed by x-ray examination, and on June 8, 1956, condylectomy and cartilage block arthroplasty were performed on the left side. There was no difficulty whatsoever in holding the cartilage in position immediately after the condyle was removed. No direct fixation other than intermaxillary was necessary.

With a certain amount of occlusal equilibration, this patient has shown marked improvement since the last operation, and has had good opening of the mandible to the extent that the posterior teeth have been restored by means of full cast crowns.

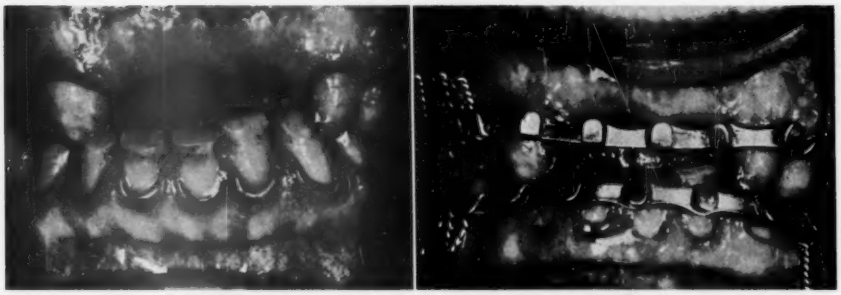
At the time of the last examination on July 21, 1958, the patient had no pain, asymmetry or limitation of motion.

New Cases

CASE IV. J. E., a thirty-three year old white man, was first seen on April 23, 1955, complaining of bilateral pain in the temporomandibular joint area and limitation of opening of the mandible. This patient was injured in an automobile accident on July 9, 1954, at which time he incurred a fracture of the right condyle and a partial dislocation of the left condyle. The injury was treated by intermaxillary fixation, but the patient had increasing pain during the months that followed and was unable to open the mouth fully.

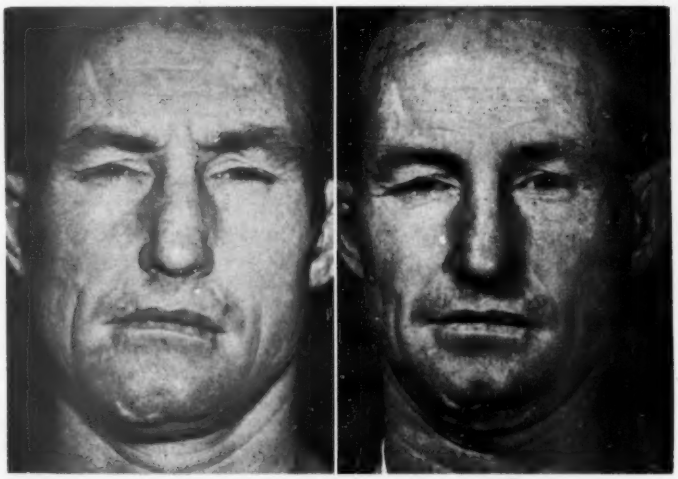
X-ray films revealed an old fracture line on the right condyle with irregularity of the superior surface of the head of the condyle. On the left, there was evidence of atrophy of the head of the condyle with flattening of the superior surfaces. On June 1 left condylectomy was performed with replacement by an autogenous block of rib cartilage.

Unfortunately this patient was not followed up by the operating surgeon, and it seems that there was some change in the occlusion following surgery. The patient was not seen again until February 16, 1959, at which time it was noted that there was a definite shift of the mandible to the right. (Figs. 2A and 3A.) He complained of intermittent severe pain



2A 2B

FIG. 2. Case IV. A, before correction of malocclusion by resection of portion of cartilage block. B, after correction of malocclusion.



3A 3B

FIG. 3. Case IV. A, before reduction of excess cartilage block. B, after reduction of excess cartilage block.

in the area of the right temporomandibular joint and a constant soreness in the area of the left ramus of the mandible. X-ray films revealed that the Kirschner wire which had been placed in the left zygoma had become dislodged and migrated to a position posterior to the ramus of the mandible. (Fig. 4.)

On March 2, 1959, through a combined preauricular and Risdon incision, the left temporomandibular joint area was exposed and a 3 mm. section was removed from the superior aspect of the cartilage block. This was preserved for microscopic study. (Fig. 5.) The trunk of the facial nerve was then located and retracted. With the use of a landmark and an x-ray film, the dislodged Kirschner wire was located and removed.

Postoperatively with the use of arch bars and elastics, traction was exerted so as to pull the mandible back toward the left side. On the date of the last examination, April 27, 1959, the patient had no pain in the right temporomandibular joint area. There was no soreness in the left ramus and the asymmetry was considerably improved. (Figs. 2B and 3B.)

Comment: This case demonstrates the problem that may result from overcorrecting the vertical dimension with the cartilage block. It is better to have the cartilage block too small rather than too large. This also gave us the chance to study both clinically and microscopically a cartilage block which had been used for reconstruction of the temporoman-

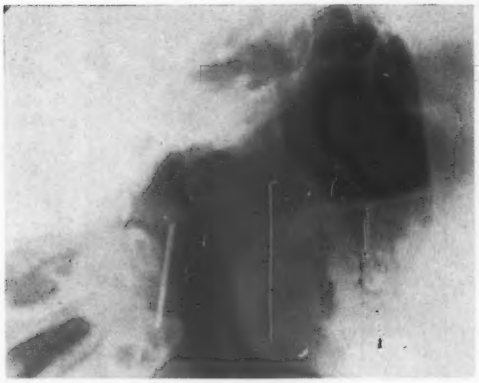


FIG. 4. Case IV. X-ray showing displacement of Kirschner wire from root of zygoma.

dibular joint. This graft, removed almost four years after insertion, appeared viable and compatible with normal rib cartilage. (Fig. 6.)

On the operating table it was noted that the greatest amount of movement was a torsion motion due to the elasticity of the cartilage, and that there was actually more movement between the superior surface of the cartilage block and the glenoid fossa than there was between the inferior surface of the cartilage block and the stump of the ramus.

CASE V. H. K., a twenty-eight year old white man, was first seen on April 23, 1955. He had been injured in an automobile accident in April 1954, incurring a fracture of the right body of the mandible. This had been treated by external pin fixation, resulting in good union. However, subsequently there was considerable pain in the right

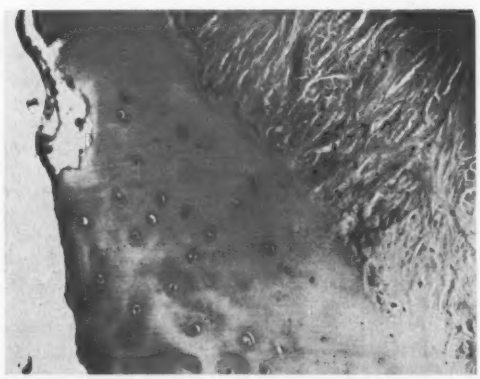


FIG. 6. Case IV. Photomicrograph showing junction of cartilage block with glenoid fossa and evidence of viable cartilage.

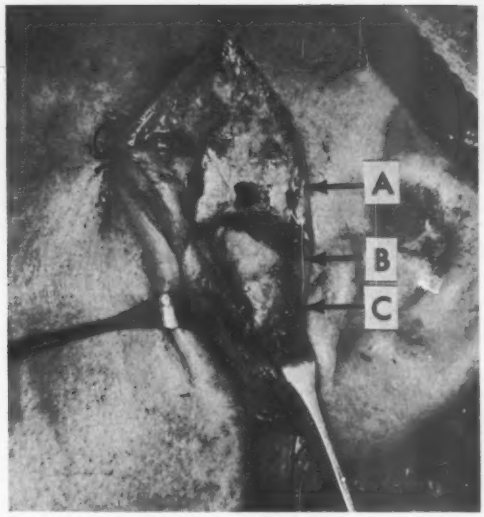


Fig. 5. Case IV. Photograph showing operative exposure of previously inserted cartilage block. The block proved to be too large and had to be reduced. A, root of zygoma. B, cartilage block. C, stump of mandible.

temporomandibular joint accompanied by locking and clicking noises. Occlusal equilibration failed to relieve this, and on May 27, 1955, meniscectomy was performed. During the immediate weeks following surgery, there was relief of pain; however, on July 14 there was a recurrence of the clicking and by October 9 pain had begun to recur. Laminagrams made at this time showed irregularity of the contour of the right mandibular condyle.

On October 31 condylectomy and cartilage block arthroplasty were performed. The cartilage block was secured very nicely without direct fixation, and intermaxillary fixation was instituted and maintained for three and a half weeks. Following removal of intermaxillary fixation, it was noted that the patient had good motion without locking or pain. There was no lateral motion, however. At the time of the last examination, March 18, 1959, the patient had continued good function without clicking or locking and without pain.

CASE VI. E. G., a fifty-one year old woman, was first seen on June 14, 1955, complaining of intermittent pain, spasm and marked shift of the mandible to the right. This patient's complaints were somewhat bizarre in that she had an apparent uncontrollable spasmodic shift of the mandible to the right occurring intermittently and without any definite pattern. (Fig. 7.) Symptoms of pain, joint noise and locking had developed some five years earlier which were aggravated by loss of the posterior teeth two years later. Condylectomy had

been performed two years prior to the patient's initial visit, which apparently accounted for the bizarre spasmodic shift of the mandible.

On September 23 the right temporomandibular joint area was exposed. Due to the radical excision of the condyle, the space between the stump of the ramus and glenoid fossa was of considerable degree. A piece of autogenous rib cartilage was placed in this area, but was not large enough to be wedged into position. No intermaxillary fixation was instituted following surgery since the patient had a full upper denture and it was believed that the cartilage block was of insufficient size. However, the patient did quite well and with fibrosis of the tissues around the cartilage block, apparently, there was stabilization in this area with disappearance of the spasmodic shifting of the jaw and pain.

In January 1956 the patient was in an automobile accident at which time she was struck on the left jaw, apparently dislodging the cartilage block, and the original difficulties returned. Subsequent attempts at conservative therapy by muscle exercises and by construction of a partial denture and equilibration gave some limted improvement. To date, the patient has chosen not to have any further surgery.

Comment: This case characterized by marked shift was apparently corrected with the cartilage block arthroplasty, in spite of the extent of the defect, until the reconstruction was damaged in a subsequent automobile accident.

Case VII. L. K., a twenty-two year old white woman, presented on July 29, 1957, with the complaints of severe pain in the left temporomandibular joint, marked shift of the mandible to the right and limited opening of the mandible. (Fig. 8A.) The patient had incurred fractures of the mandibular symphysis and the right condyle in an automobile accident approximately one year earlier. The fractures were reduced three days following injury, and three weeks later open reduction was effected on the right mandibular condyle. This condyle subsequently resorbed. Intermaxillary fixation was continued for approximately three months.

Six months after injury, because of a sudden shift of the jaw to the right, the patient was returned to her original doctor who reinstituted intermaxillary fixation for an additional two and a half months. Two weeks later the jaw again shifted to the right and the patient was referred to another medical center where intermaxillary fixation, splints and psychotherapy, including shock therapy, were tried without improvement.

On August 9 cartilage block arthroplasty was performed in the area of the right temporomandibular joint. The condyle was missing, and it was not necessary to perform any direct fixation.

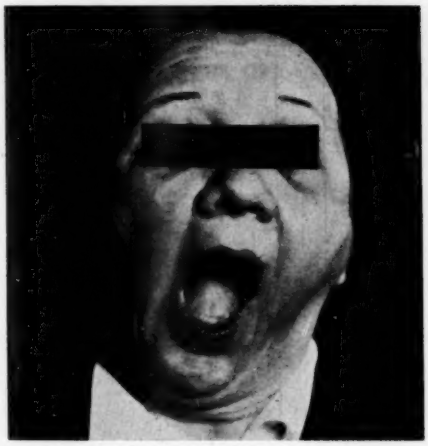


Fig. 7. Case VI. Photograph demonstrating spasmodic shifting of mandible.

Intermaxillary fixation was maintained for approximately three and a half weeks.

On September 5 the patient was free of pain, but there was still a shift of the jaw to the right on opening. Consequently, on September 27 condylectomy and cartilage block arthroplasty were performed on the left side. No direct fixation was necessary. Intermaxillary fixation was maintained for three weeks. On November 19 fixation was discontinued. At that time the patient had good opening in the midline with no pain.

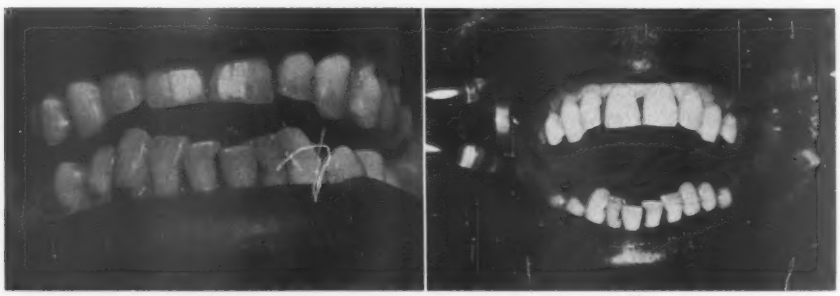
The patient was seen again on January 9, 1958, at which time she seemed to have an excellent result. (Fig. 8B.) There was no pain and the jaw could be opened freely without deviation.

Comment: This patient was unable to tolerate loss of the condyle following trauma. Marked shift, pain and limitation of motion developed. Unilateral reconstruction was not sufficient and the patient obtained relief of her complaints only after bilateral arthroplasty.

Case VIII. L. N., a thirty-six year old Negro man, first presented on October 8, 1957, with the complaint of limited opening of the mandible. The distance between the incisor teeth on opening was limited to 4 mm. (Fig. 9A.) The patient gave a history of having been in an automobile accident in October 1951. He was treated at Brooke Army Hospital in San Antonio, Texas. Injuries included a fracture dislocation of the left condyle of the mandible and an oblique, compound, comminuted fracture of the right body of the mandible. Injuries were treated by intermaxillary fixation on October 22. Two weeks later intraoral open reduction was

8A 8B

FIG. 8. Case VII. Appearance before (A) and after (B) correction of post-traumatic asymmetry by bilateral cartilage block arthroplasty.



9A 9B

FIG. 9. Case VIII. A, preoperative intraoral photograph. B, intraoral photograph following bilateral cartilage block arthroplasty.

performed on the right body of the mandible. On November 26 a tooth in the line of fracture was removed. The total period of intermaxillary fixation was approximately three months. On January 3, 1952, it was noted that the patient had marked trismus, and he was told to do jaw exercises. The trismus has persisted until the present time. There were no other abnormalities.

Surgical correction was performed in four stages as follows: On October 21, 1957, through a preauricular approach, the left condyle area was exposed. There was a massive bony ankylosis, including both the condyle and coronoid process. Ostectomy was performed at the junction of the condyle and glenoid fossa to obtain free motion. On October 24 it was noted that the patient was able to increase his opening to 10 mm. following use of overhead traction applied to steel wires inserted at the angle of the mandible. On November 8, two weeks after the initial procedure, ostectomy was performed on the right side. There was a fibrous ankylosis in this area but no massive overgrowth of bone. One week later, on November 15, cartilage block arthroplasty was performed on the left side, and on the right side on November 22. The cartilage block was wedged into the ostectomy space with ease, and no direct fixation was necessary. Intermaxillary fixation was instituted on November 23 and maintained for two and a half weeks. At the end of this time the patient was able to open his mouth 15 mm.

On December 17 a dynamic bite opener (Fig. 10) was instituted, and on January 10, 1958, the patient was able to open his mouth 21 mm. (Fig. 9B.) The patient has been subsequently seen on July 24 and October 1, 1958, with continued good result.

Comment: This case represented bilateral ankylosis characterized by marked bony hypertrophy on the left side, a condition which might have been handled more easily by an Esmarch type of osteotomy but probably with less satisfactory results. Surgical correction might preferably have been done in two stages rather than four.

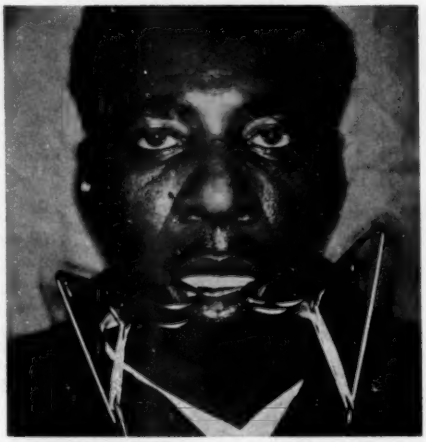


FIG. 10. Dynamic bite opener used in patient in Case VIII.

COMMENTS

All of the aforementioned procedures have been performed through a preauricular incision. This has presented no unusual difficulty and has been free of complications. In certain instances, particularly those cases of chronic deformity, the greatest difficulty has been immobilizing the cartilage block. This presents no problem when performed at the time of resection of the condyle and in conjunction with correction of ankylosis without deformity.

Longacre and Gilby [*12*] have used strips of fascia lata to secure the graft. Stuteville and Lanfranzi [*19*] have used wire and catgut suture. In most instances direct fixation has not been necessary; however, we have used Kirschner wire fixation in three cases.

Performing the reconstruction in the area of the original joint theoretically should allow for better function. The cartilage block is easily carved with a knife to proper shape and is sufficiently dense to maintain vertical dimension. It is one of the easiest grafts to transplant, presenting none of the technical difficulties or potential hazards of prosthetic implants.

Longacre and Gilby [*12*] and Walker [*21*] immobilize these patients for one week or less and then begin chewing exercises. Stuteville and Lanfranzi [*19*] start these patients on opening exercises immediately postoperatively. It has been our feeling that a period of three weeks of immobilization would allow sufficient fibrosis to take place to prevent displacement of the graft and not sufficient time to allow development of ankylosis. Longacre [*14*], however, has recorded one instance of ankylosis following cartilage block arthroplasty. We have not found it necessary to remove any portion of the zygoma or zygomatic arch as suggested by Lillianthal [*11*] and Henderson and New [*8*].

This procedure does not solve the problem of growth disturbances in those persons affected at an early age, other than to allow a method of restoring function in instances of ankylosis. The method of transplanting growth centers advocated by Stuteville and Lanfranzi [*19*] and Sarnat [*18*] is as yet unproved. The patient shown in Figure 11 was treated by this method utilizing the head of the third metatarsal.

It was interesting to us that in the one instance in which we had an opportunity to examine the functioning cartilage block, more motion was perceptible at the superior aspect than at the inferior. Walker [*22*] has also noted this in the postmortem examination of a patient who previously had had a cartilage block arthroplasty.

Ankylosis. Sixteen patients with ankylosis have been seen in our clinics during the past six years. The age range was from twenty-three months to fifty-seven years. The origin of these cases and the procedures utilized in treatment are listed in Table 1.

Ankylosis has been treated by simple ostectomy without interposition of substance. This invites the possibility of recurrence of the ankylosis. It would seem advisable to use some substance between the bone fragments in order to maintain free motion and avoid deformity. Local flaps of muscle or temporal fascia may be feasible; however, materials of choice would seem to be the dermal graft, as described by Georgiade et al. [*5*], or autogenous cartilage.

A certain number of these patients, particularly when the ankylosis is fibrotic in nature, may respond very well to bite openers. We have had good results in five patients: three had postpolio fibrosis of the muscles of mastication, one had rheumatoid arthritis and one had post-

11A 11B

FIG. 11. A, appearance of patient at three years of age before metatarsal transplant. B, appearance at age five, two years after metatarsal transplant to right condyle for correction of ankylosis and cessation of growth.

traumatic arthritis. When surgery has been necessary, the bite opener has also played a most important part during the postoperative period.

Utilizing cartilage, one may treat bilateral ankylosis during the same procedure without fear of postoperative retrusion or open bite.

Post-traumatic Arthritis Associated with Pain. Two cases presented herein were of this type. Both patients had been injured in automobile accidents, and in neither case was there actually a fracture of the condyle on the side where the temporomandibular joint pain developed. There was, however, x-ray evidence of bony changes in the head of the condyle. One failed to respond to meniscectomy. Both patients are now free of pain and functioning satisfactorily. It seems, however, that the procedure of high condylectomy, wherein the meniscus is left in position, would be a simplier method of treatment. Hayward has recently described recurrence of the temporomandibular joint pain syndrome in a patient who underwent high condylectomy. Henny and Baldridge [7] state that some of their patients have had recurrence of pain, but they believe this is on a basis of missed diagnoses.

TABLE 1
STATISTICAL ANALYSIS OF CASES OF ANKYLOSIS

	No. of Cases
Etiology:	
Rheumatoid arthritis	5
Trauma	5
Poliomyelitis	3
Hydrargyrism	1
Infection	1
Neoplasm	1
Treatment:	
Bite stretcher	5
Cartilage block arthroplasty	5
Excision of bone with dermal and skin graft	1
Coronoidectomy	1
Condylectomy	1
Metatarsal graft	1
Dermal graft	1
No treatment	1

Deformity. The patients benefiting most from this procedure have seemed to be those with open bite, retrusion or shift (sometimes associated with pain) following loss of the condyle from disease, trauma or surgery. Of the five cases in this group, three had some degree of ankylosis. The answer to the problem of fractured condyles remains somewhat perplexing. The work of Stuteville and Lanfranzi [19] and Sarnat and Engel [17] indicates that open reductions may be advantageous. However, we still prefer to treat most fractured condyles conservatively, believing that in those patients in whom problems develop, cartilage block arthroplasty can be used.

As far as growth disturbance is concerned, it is possible that harm may be done by surgery as well as injury. Some recent work by Walker [22] indicates the possibility that intermaxillary

fixation may be more important in these cases than direct fixation of the fragments.

We have found in two instances of unilateral shifting that bilateral reconstruction was eventually required to eliminate the patients' complaints.

SUMMARY

A follow-up study is presented of three patients previously reported on, and five additional cases are described. The total group of eight cases may be divided as follows: postcondylectomy deformity, five; traumatic arthritis, two; ankylosis, one. One complication characterized by dislodgement of a Kirschner pin and overcorrection of vertical dimension is presented. Follow-up on these cases ranged from five years to three months.

CONCLUSIONS

1. Autogenous rib cartilage has been proved to be a suitable material for use in reconstruction of the temporomandibular joint.

2. Autogenous rib cartilage has the following advantages: (a) it is easily shaped with a knife; (b) it is easily transplanted with a high percentage of "take"; (c) it is of sufficient density to restore and maintain vertical dimension over a period of years; and (d) it seems to be satisfactory in the prevention of recurrence of ankylosis.

3. Its greatest indication is in cases of postcondylectomy deformity, although it may be as efficient as other materials in the treatment of ankylosis without deformity.

4. It does not solve the problem of growth disturbance in cases of joint disease or trauma at an early age, although any procedure which allows function may to some extent minimize the subsequent deformity and malfunction.

5. High condylectomy is probably the procedure of choice for the refractory posttraumatic painful joint.

6. The problem of the fractured condyle is still not wholly understood. However, residual problems following either conservative or surgical treatment for this condition may be corrected by reconstruction with autogenous cartilage.

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Maxillofacial Trauma and the Frontal Sinus

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TRAUMA to the maxillofacial area may involve the frontal sinuses with immediate or delayed effect. The prominence of the front of the head makes this area prone to injury.

ANATOMIC CONSIDERATIONS

Certain anatomic and functional aspects peculiar to this region of the face must be taken into account.

The frontal sinus is a cavity of varying size in the frontal bone, with its most important relations being the anterior cranial fossa posteriorly and the orbit inferiorly. The drainage of this cavity is into the middle meatus of the nose. It may drain directly into the frontal recess, either above or continuous with the ethmoid infundibulum. The infundibulum is a crescentic groove in the lateral nasal wall, located between the uncinate process and the bulla. The uncinate process is the ridge that extends superiorly from the inferior turbinate, while the bulla is the ground lamella of the bullar ethmoid cells. (Fig. 1.) Occasionally drainage may be above the ethmoid bulla. The frontal sinuses may be entirely or partially absent. They may be encroached upon by extending cells from the ethmoid labyrinth.

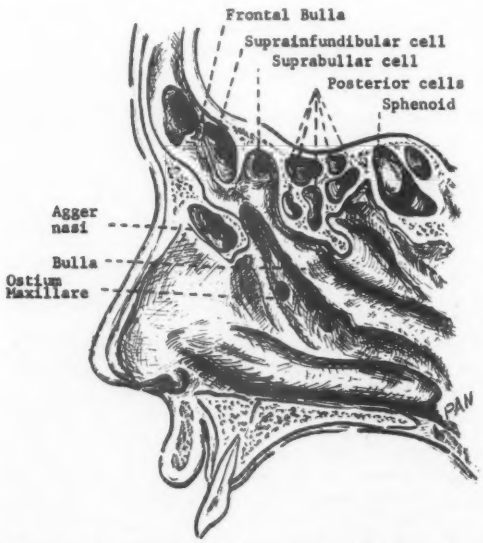

FIG. 1. Drainage of the frontal sinus is shown in a section of the lateral wall of the nose. It drains between the uncinate process and the bullar cells into the middle meatus. (Adapted from: VAN ALYEA, O. E. [1].)

The frontal sinuses are lined by pseudostratified columnar ciliated epithelium which secretes mucoid material from the goblet cells. Mucous glands in the tunica propria are primarily at the ostium and in the mucosa of the nasal cavity.

Any interference with the drainage and aeration of this cavity may result in stagnation of fluid, subjecting it to infection or production of an expanding cyst-like cavity known as a mucocele.

TYPES OF INJURY

Injury may involve only the frontal sinus, or be part of numerous facial injuries. It may be blunt or penetrating in type. A blow to the head by the steering wheel of an automobile, for instance, is capable of crushing the frontal plates with little or no other injury.

Fractures of the middle part of the face, including the nose, maxilla and orbit, may complicate frontal damage. In such multiple injuries, a frontal fracture may sometimes be overlooked or treatment deferred until after repair to other areas.

Other types of trauma to the frontal area include surgery on the sinus and procedures on the nose. When the ethmoid labyrinth is

FIG. 2. Two photographs of mucocele, each characterized by displacement of the orbital contents by the expanding sinus lesion. In the patient to the left there was a definite history of trauma to the frontal area, while in the one to the right there was a nasal injury.

damaged by curetting or when the middle turbinate forms synechiae after surgical manipulation, obstruction to drainage of the nasofrontal recess can occur.

In rhinoplastic procedures it is worth while to consider the proper function of the middle meatal area as well as the cosmetic result. The external distortion of the nose may signify even greater internal deformity. A deviated septum, for example, lying high in the nose may produce severe nasofrontal obstruction.

SEQUELAE

Numerous sequelae are related to trauma involving the frontal sinus. These include: chronic frontal sinusitis, mucoceles, pneumatoceles, fistulas into the orbit and osteomyelitis. These sequelae may not become apparent for long periods after the original damage. In a study of trauma to the frontal sinus, Work [2] found that most treatment for frontal trauma was instituted five to eight years after the original injury, some as long as thirty-five years later.

Chronic frontal sinusitis may sometimes be traced to an injury to the nose. A patient's history will occasionally reveal an attempt to correct a nasal deviation by digitally replacing the external parts. A chronic obstruction of the nose occurs on the injured side. What probably happens is that the septal cartilage and turbinates are displaced so that drainage of the middle meatus is impaired. As time goes on, a chronic infection becomes harbored in the partially occluded nasofrontal area. When surgical procedures become necessary to relieve the infection, the steps responsible for the condition must be retraced.

Mucocele and pyomucocele are other sequelae of trauma to the frontal sinus. (Fig. 2.) A mucocele is defined as a mucous retention cyst, with distention of one or more of the sinus walls. Tamari and O'Neill [3] have theorized about the pathophysiology of a mucocele. They suggested that a submucosal injury with hemorrhage occurs. The submucosal extravasation causes the mucosa of the sinus to become elevated, with the production of exudate beneath it. A herniation of the elevated mucosa gradually contacts the mucosa on one of the sinus walls, and pressure produces bone absorption. The bone deformity externally is a result of the expanding mucosa beneath. When trauma is a factor, it may have occurred months or years earlier. The differential diagnosis of this entity is important, for it may be mistaken for a tumor of the ocular structures, when in reality it is an extension laterally from the frontal or ethmoid area. Abscess, neoplasm of the brain or herniation of the meninges must also be differentiated,

FIG. 3. Acute frontal osteomyelitis in a man who bumped his head in what he considered to be a minor injury about a month before onset of acute symptoms.

since the symptom of headache frequently suggests intracranial disease.

Although osteomyelitis of the frontal bone is seen less frequently now than a few decades ago, the disease can and does occur when trauma involves the frontal sinus. (Figs. 3 and 4.) An osteomyelitic process may be localized or generalized. The pathologic condition usually is explained by the infection which passes from the mucosa of the sinus by way of the diploic veins into the bone. Infection may pass through the bone to the dura with very little visible roentgenologic change in the bone.

TREATMENT

Early treatment is based on the understanding and extent of the involvement. No treatment may be needed in instances of little or no displacement of bone. Treatment may have to be deferred because of the general condition of the patient or because evaluation is uncertain.

When there is crushing of the frontal sinus or its course of drainage is involved, definitive early treatment by débridement, reduction and replacement of bone becomes necessary. The posterior bony table of the frontal sinus may have to be examined, and injury to the dura and brain evaluated. (Fig. 5.) Very early reduction of an injury of the middle part of the face helps to prevent later sequelae. Antibiotics are an important adjunct in early treatment. The frontal nasal drainage should be insured, and sometimes a catheter should be placed temporarily from the frontal sinus into the nose.

FIG. 4. Roentgenogram shows frontal osteomyelitis; left sinus is completely filled with pus (see Figure 3).

Late treatment may be instituted many years after the original injury for the sequelae that have already been mentioned. Most of the time these sequelae are not seen or treated by the persons who attended the original injury. Thus, the long term effect of these sequelae may not be appreciated.

Chronic frontal sinusitis is treated by establishing drainage into the nose, usually by intranasal procedures or combined with an external approach to clean out diseased frontal tissue or obstructing ethmoid cells. Allowing the affected frontal sinus to drain to the other side is frequently adequate. Occasionally an obliterative type of operation is necessary when conservative surgery on the external frontal sinus has failed. This has the disadvantage of resulting in cosmetic deformity, although repair may be possible later.

Osteomyelitis of the frontal bone is usually an extension of a septic thrombophlebitis, as suggested previously. This requires adequate antibiotic therapy with elimination of necrotic bone and sequestra where necessary. Formerly, radical removal of the frontal bone was advocated, but with early and judicious use of the broad-spectrum antibiotics, conservative management has gained increasing support.

Treatment of a mucocele of the frontal sinus consists of complete surgical removal of

FIG. 5. Contrasting forms of treatment of fractures of the frontal sinus. To the right is seen a roentgenogram of fracture of an inner table, with slight depression and comminution. A conservative approach was used, and after several months' duration the patient remained asymptomatic. To the left is seen a fractured frontal sinus in which there was cerebrospinal rhinorrhea. This was reduced after closure of a tear in the dura.

the contents and walls of the cyst-like mass under direct vision, and insuring patency of drainage of the frontal sinus. Incomplete removal and inadequate drainage will cause recurrence.

SUMMARY

The early and delayed effects to the frontal sinus from facial injuries should be kept in mind. In dealing with maxillofacial trauma, the sequelae of frontal injury, including chronic frontal sinusitis, osteomyelitis and mucocele, may present a distressing problem to the patient. Treatment consists of establishing drainage, the use of antibiotics and removal of irreversibly diseased tissue.

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Neurosurgical Procedures for the Control of Intractable Pain in Malignancies of the Head and Neck

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MANY patients with malignancies of the head and neck survive for long periods of time, even though their disease has not been controlled by surgical or radiation therapy. They usually die slowly of the local effects of the disease rather than from distant metastases to the central nervous system, the liver or the lungs. Many of these unfortunate people have severe pain, and this symptom may date either from the onset of the disease or from the first sign of its recurrence. In some instances, the pain may be markedly increased by swallowing and, as a result, the patient may deteriorate rapidly because of an inadequate intake of food. The physician caring for these patients has a choice of several plans of therapy. Local excision or radiation may be very helpful in relieving pain. The removal of a radionecrotic mandible may give surprising relief of pain. However, in many patients local therapy is not possible. The physician may decide to accept the situation and relieve the patient with narcotics. In many cases, this approach may be justified or at least the only one possible. Unfortunately, however, quite a few of the patients so treated outlive the relief given by the drugs and then have, in addition to pain, the problems of addiction to and dependency on narcotics. Alternatively, a neurosurgical approach to the problem may be elected. With this approach one accepts the fact that nothing further can be done about the disease itself, but that some form of symptomatic relief can be achieved either by altering the patient's response to pain or by preventing the sensation of pain from reaching conscious levels. In any long term illness, proper planning of therapy is important; insofar as operations for the relief of pain are concerned, this planning is specially important. There would seem to be a proper time to perform a pain-relieving operation in relationship to the amount of pain experienced, the patient's physical state, his life expectancy and other possible forms of therapy. Local procedures, if reasonable, should be tried first. If these fail, a definite decision as to further management should be made. The problem of what constitutes pain, and especially intractable pain, is an individual matter. Beecher [2] has recently written that "Pain cannot be satisfactorily defined, except as man defines it introspectively for himself." He has further stated that "No convincing demonstration has yet been given that the pain threshold is a constant from man to man, or from one time to another in a given man." It is my impression that pain-relieving operations provide the best results when performed early, certainly before the patient has received any quantity of narcotics. They should also be performed at such a time that the patient's convalescence will not probably take up the major part of his life expectancy. It is difficult for many physicians to advise a surgical procedure knowing that it will only give symptomatic relief and that the patient will probably succumb, if not to the operation, to the primary disease. This attitude leads to procrastination at the best, and at the worst to addiction. Patients who have received any amount of narcotics, usually do badly and are difficult to manage if pain-relieving operations are later attempted; although they may be relieved of the primary pain, they will still feel the need for narcotics for any other discomfort. It has seemed to me that the best results have been achieved in patients somewhere between the aspirin and

codeine stage. The patient's physical state is of some but not great importance, since most neurosurgical operations for the relief of pain can be performed with local anesthesia and with but little blood loss or surgical trauma.

The various neurosurgical procedures are based upon a knowledge of the anatomy and physiology of the pain pathway in the nervous system and have developed as this knowledge has accumulated. Destruction of various portions of the nervous system will either alter the patient's reaction to pain or prevent the sensation of pain from reaching the level of consciousness. Pain as a sensory impulse is presumed to arise from stimulation of fine naked nerve endings in contrast to the more complicated structures subserving other modalities of sensation. Further transmission of these impulses occurs through various peripheral and cranial nerves and probably via small, unmyelinated fibers. The sympathetic nervous system is an important pathway insofar as visceral pain is concerned, but it is not important as a factor in pain in the head and neck. The final pathway for peripheral sensory impulses is through the dorsal root. Within the spinal cord, the fibers subserving pain lie first in Lissauer's tract, near the entrance of the dorsal root. Within a few segments, these fibers join with second order neurons and cross to ascend in the ventrospinothalamic tract to the thalamus. Pain fibers originating in the various cranial nerves have a somewhat analogous course in the medulla. Conscious perception and interpretation of pain is achieved by an interplay of the impulses from the thalamus and various cortical and subcortical areas. The sensory cortex and the frontal lobes are most important. Operations below the thalamic level, and perhaps those at the level of the sensory cortex, prevent pain from reaching consciousness; whereas those operations severing the pathways between the frontal lobes and the thalamus alter the patient's emotional response to pain and, although the patient still has pain, he is not bothered by it.

The peripheral and cranial nerves involved in pain in the head and neck are: the first four cervical nerves, the trigeminal nerve, the facial nerve, the glossopharyngeal nerve, and the vagus nerve. Knowledge of the effects of section of these nerves has developed slowly. Section of the peripheral branches of the trigeminal nerve for the relief of facial pain dates from the time of Louis XIV; but not until the early part of this century did Frazier, at the suggestion of Spiller [*13*], develop a practical operation for the permanent relief of trigeminal neuralgia by a preganglionic section of this nerve. Prior to this time, surgeons had tried to excise the semilunar ganglion with considerable mortality, or had performed peripheral neurectomies with only temporary relief. Section of the trigeminal nerve was found to relieve the painful paroxysms of trigeminal neuralgia. However, the sensory loss did not seem to include deep facial pain which Davis [*4*], in 1923, found to be transmitted by a portion of the facial nerve, the nervus intermedius. In 1924, Adson [*1*] reported the successful treatment of glossopharyngeal neuralgia, which causes paroxysms of pain in the throat, by division of the glossopharyngeal nerve. Shortly after this, Fay [*6*] published a series of papers concerning his experiences with intracranial section of the ninth and tenth cranial nerves, as well as the upper cervical roots, in an attempt to control the pain of incurable carcinoma of the throat. Next, Dandy [*3*] developed an operation by which the trigeminal nerve could be sectioned through the posterior fossa. Thus, it was possible to section both the trigeminal and glossopharyngeal nerves at the same time. In 1942, Furlow [*7*] reported his experiences in sectioning the nervus intermedius of Wirsburg, a portion of the facial nerve, for "tic douloureux of the nervus intermedius," and he noted that section of this small filament of nerve could relieve deep facial pain. In the same year, Tarlov [*15*] reported some anatomical studies which showed that there were sensory fibers in the "cephalic one-third of the vagus-spinal accessory complex," and that these fibers might be important in pain in the head and neck. In 1949, Hunter and Mayfield [*9*] gave a striking demonstration of the importance of upper cervical nerve roots in cephalic pain.

Thus, an anatomic and physiologic basis for operations for the relief of intractable pain in the head has been available for some time. However, the results obtained by sectioning various combinations of these peripheral and cranial nerves did not always fulfill the expectations of either the surgeon or the patient, usually, we believe, because of an inadequate denervation of the pain-producing areas. However, competent surgeons have reported the persistence of pain after seemingly complete

TABLE 1
NERVES SECTIONED

Nerves	No. of Cases
Trigeminal only	5
Glossopharyngeal only (bilateral)	1
Trigeminal and glossopharyngeal	10
Trigeminal, glossopharyngeal and nervus intermedius	2
Trigeminal, glossopharyngeal and vagus	6
Cranial nerves and cervical roots	5

section of the aforementioned nerves [*18*]. With increasing knowledge of the anatomy of the pain pathway in the central nervous system, new operations were proposed. In 1938 Sjöqvist [*11*] described the sectioning of the descending root of the trigeminal nerve in the medulla; and in 1942 Walker [*16*] described mesencephalic tractotomy for the relief of certain types of pain. With the development of human stereotactic apparatus, both here and abroad, methods for the interruption of pain pathways at even higher levels have been described by Spiegel and Wycis [*12*] and Talairach et al. [*14*]. However, the clinical results of these procedures have not seemed to justify the technical difficulties inherent in many of these operations. Furthermore, distressing sensory disturbances have been reported by Drake and McKenzie [*5*] after mesencephalic tractotomy. McKenzie has also [*10*] reported it to be difficult to achieve a complete permanent sensory loss after section of the descending root of the trigeminal nerve in the medulla. Frontal lobotomy, a simple operation, has also been performed for the relief of intractable pain and may very well be justified in certain instances. However, the psychic loss which usually seems to occur after this operation would seem to be too great to justify its routine use. White [*17*] has likened it to a legalized form of euthanasia.

We believed that a re-evaluation of the results of treatment of the intractable pain arising from malignancies of the head and neck was desirable and have, therefore, reviewed the material available in the Library of Neurosurgery of Northwestern University Medical School. We have considered only those patients whose intractable pain in the head and neck has been treated by section of the cervical or cranial nerves. Seventeen patients make up the present series. Three of these were operated upon by Dr. Loyal Davis in the period between 1939 and 1942, the remaining since that time. There were sixteen men and one woman. Their ages ranged between thirty-seven and seventy-four years. The origins of the tumors were sometimes difficult to determine when the patients were presented for our consideration. There were three cases of carcinoma of the skin of the face; a similar number originated from the tongue, and another three from the nasopharynx. There were two patients each with carcinoma of the nasal sinus and larynx, and one patient each with carcinoma of the tonsil, gingiva, deep lobe of the parotid gland and buccal mucosa. The pain in all cases, except two, involved the face and jaw. In four patients, there was also pain in the throat and mouth, and in five severe pain in the neck. The pain was confined to the tonsillar region in the one patient with carcinoma of the tonsil and was bilateral because of a painful radiation ulcer which occurred on the side opposite the primary tumor. In one patient with carcinoma of the tongue, the pain was almost entirely in the mouth and throat. Seven patients had great pain on swallowing, although pain in the throat was not always present at other times.

In all the patients except one, at least the trigeminal nerve was cut, either by itself or in combination with other cranial and cervical nerves. (Table 1.) All the patients were operated upon in the sitting position, and in one patient, the procedure (bilateral section of the glossopharyngeal nerve) was performed in two stages. Local anesthesia alone was employed in most of the patients although this was usually supplemented by small amounts of intravenously administered meperidine. In the first four patients in the series, section of the trigeminal nerve was performed through a temporal approach. Although this procedure is successful for the relief of pain in trigeminal neuralgia, it is not as efficacious for the relief of pain in cancer since a complete section is difficult, if not impossible, through this route. In the remaining patients the various cranial and cervical nerves were sectioned through a posterior fossa approach, which might include an extension of the incision to expose the cervical roots through a small laminectomy. The patients tolerated the procedure remarkably well. There was one immediate operative death from air embolism. Another patient died

within a week of surgery, presumably from pulmonary complications since in addition to the malignancy he had extensive pulmonary tuberculosis. Another patient died on the fourteenth postoperative day when the internal carotid artery broke down in the nasopharynx.

The results of pain-relieving operations are hard to evaluate. However, the results in ten patients seemed to justify the surgical procedure. The operation was considered successful if the patient was relieved of pain until the time of his death. We have been particularly impressed by the patients with dysphagia who after operation are usually able to swallow both liquids and solids, frequently gain weight, and leave the hospital. We were unable to evaluate the result of the operation in three patients because their survival time seemed too brief. Four patients were not satisfactorily relieved of pain. One of these had facial pain from carcinoma of the larynx. Trigeminal nerve section was performed through a temporal approach, with good immediate relief of pain. Shortly after the patient was discharged from the hospital, pain developed in his throat. Further surgery was considered futile by all concerned because of the patient's generally poor physical condition. Another patient had extensive carcinoma of the face and was treated by trigeminal neurectomy through a temporal approach. Postoperative sensory testing revealed an incomplete nerve section. Although he was relieved of the pain for about a month, frontal lobotomy was eventually performed because of the occurrence of deep facial pain. Two other patients had relief obtained in the immediate postoperative period but the pain recurred before their deaths. In one patient with a carcinoma of the deep lobe of the parotid gland which invaded the middle cranial fossa, the tumor was found at surgery to extend into the posterior fossa. Section of the fifth nerve was performed through the tumor and the patient's facial pain was relieved. However, multiple palsies of the cranial nerves and headache developed from further growth of the tumor, and the patient died four months later. In another patient with epidermoid carcinoma of the nasopharynx, bleeding from a large plexus of veins about the fifth nerve made us settle for partial sectioning. This patient was comfortable for about a month; he then started bleeding from the throat and required ligation of the carotid artery. He died three months later but was quite miserable with repeated bleeding and diffuse pain in the head.

TABLE II
RESULTS

Data	No. of Cases
Good relief until death	10
Unsatisfactory, pain recurred	4
Not evaluated	3
Survival times:	
35 mo.	1
12 mo.	1
4 to 5 mo.	5
2 to 4 mo.	3
Unsatisfactory relief:	
4 mo.	3
3 mo.	1

We believe that most of the unsatisfactory results can be explained on the basis of an inadequate denervation of the painful areas. We have found, as have others, that there is frequently a sensory root for the first cervical nerve and that this must be sectioned. However, we have been surprised to find that some of the patients obtained good relief with a seemingly inadequate operation. The survival times of the patients are shown in Table II.

SUMMARY AND CONCLUSIONS

We believe that the neurologic surgeon can make a real contribution to the care of these patients. If the patient's pain is in the face and throat, section of the trigeminal nerve, the glossopharyngeal nerve, and part of the vagus nerve, as well as the nervus intermedius may be sufficient. However, if pain in the neck is also present or would seem likely to develop, section of the cervical roots should also be performed. This does not necessarily have to be carried out at the time of the initial operation. Section of the nervus intermedius may be quite important for the relief of deep facial pain, but it is sometimes difficult to define this nerve, and we have sometimes been unable to section it. Pain deep in the ear is said to be particularly difficult to relieve and may be due to the impulses passing through the nervus intermedius. However, one of our patients was relieved of pain in the ear without section of the nervus intermedius. All of the aforementioned nerves may be sectioned at a single operation, using local anesthesia alone. There does not seem to be any disabling

loss of neurologic function after section of these nerves. Even section of the ninth and tenth cranial nerves does not cause difficulties in swallowing, and section of the ninth nerve bilaterally does not cause overwhelming difficulties.

The present series of patients is not as large as that reported by Grant in 1943 [8]; however, there is little in the current literature to suggest the widespread use of these procedures, and we have therefore felt justified in presenting our experience, since the newer drugs and other operations have not solved the problem.

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Disorders of the Buccal Mucosa

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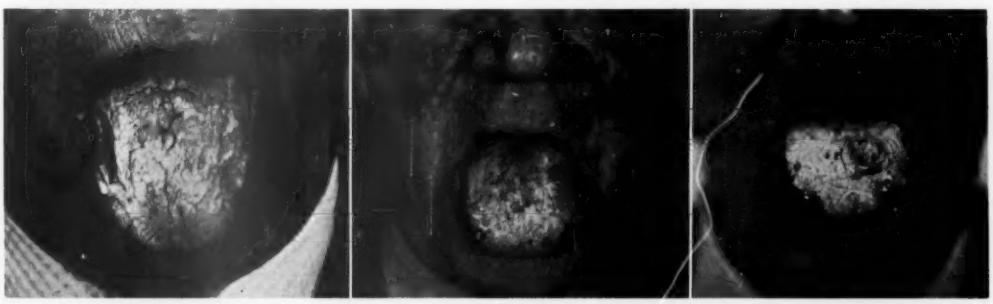
DISORDERS of the buccal mucosa are numerous, and the differential diagnosis is often difficult. They may arise locally, in conditions such as leukoplakia, mucous cysts and neoplasms; they may be due to local irritation from such sources as ammoniated toothpaste, nylon toothbrushes, mouthwashes, ill-fitting dentures and tobacco in all its forms; they may be caused by local infections such as moniliasis, streptococcus, tuberculosis, so-called trench mouth or syphilis; or they may be congenital as in hemangioma or lymphohemangioma.

First let us consider leukoplakia, a geriatric disorder commonly seen in men who have used tobacco for years, and rarely seen in women. It may, but not always does, develop into squamous cell carcinoma. I have followed up patients for years without this occurring, only to have the patient die of a coronary attack. It is an interesting fact that in addition to the association with the use of tobacco, it has been seen in association with syphilis of the central nervous system, for what reason I do not know. (Figs. 1 and 2.)

In the differential diagnosis two disorders must be considered, moniliasis and lichen planus. In both conditions dead white lesions are seen. In moniliasis the white lesions are readily removable with a curet, and in the resulting sodium hydroxide microscopic preparation the monilia fungi are more easily found than missed. In lichen planus the white lesions cannot be removed by a curet and are usually found along the interdental line (Fig. 4); also, there are almost always typical cutaneous lesions on the flexors of the wrists and other areas which establish the diagnosis. Moreover, leukoplakia fluoresces under the Wood light, and as a last resort biopsy may be performed.

As stated before, leukoplakia may eventuate into carcinoma. (Fig. 3.) For example, in a man who was under observation for some years, there were no signs of leukoplakia generating into cancer. However, eventually an ulceration developed and wide excision of the tongue was performed. The patient has since continued in excellent health without any sign of metastases. However, many carcinomas of the buccal mucosa are not preceded by leukoplakia. Another patient was given intensive x-ray



1 2 3

FIG. 1. Leukoplakia on the tongue of a patient with syphilis of the central nervous system.

FIG. 2. Leukoplakia on the tongue of a patient with tertiary syphilis. The late lesions of the skin are seen on the cheeks.

FIG. 3. Leukoplakia on the tongue with carcinomatous degeneration.

4 5

FIG. 4. Lichen planus in the usual interdental line of the buccal mucosa.

FIG. 5. Cancer of the buccal mucosa.

therapy with marked improvement, but was later referred to a surgeon who performed extensive surgery without avail. Still another patient, in whom carcinoma was not preceded by leukoplakia, was referred at once to a surgeon.

Epitheliomas of the vermilion of the lip may extend back to and involve the buccal mucosa. (Fig. 5.) I saw a patient with a large, rapidly growing squamous cell epithelioma just inside the left labial commissure. I advised excision but my chief overruled me. This case would have been ideal for immediate excision; instead the patient died a few months later.

Erythroplasia of Queyrat is characterized by a bright red plaque on the buccal mucosa; it also may be seen on the glans penis. Instead of being white, as in leukoplakia, the bright red spot may remain unchanged for varying lengths of time, but eventuates into cancer although at first there may be no microscopic indication of malignancy.

Lymphohemangioma is usually congenital and the tumor may attain a large size. Freezing with carbon dioxide snow usually is successful.

Mucous retention cysts are not uncommon and present no problem. Incision with a sharp pointed knife and fishing out the sac with an iris hook completes the cure.

Stomatitis from ingestion of drugs is a common occurrence and may present great difficulties in diagnosis. During the past few months a patient was referred to me by an internist who had referred him some months prior to a colleague of ours. The patient had three severe attacks of stomatitis making him incapable of taking anything other than liquids. I failed to elicit any history of drug taking (this is the most difficult task I encounter in obtaining a patient's history). Nevertheless, I kept the idea in mind and made all possible cultures and sensitivity tests. In a course of a few weeks the stomatitis cleared completely. About four weeks later the patient called, saying he was having a recurrence. He admitted on further quizzing that he had taken a capsule prescribed for his wife, and he recalled having taken three capsules before each attack. A druggist reported that the capsules contained Nembutal.®

For centuries, mercury has been the prime cause of stomatitis called salivation. However, in the more recent treatment of syphilis, the use of bismuth has been quite successful in sensitized persons.

Syphilis has a predilection for the buccal mucosa and may manifest itself as a chancre, a mucous patch, a gumma of the tongue, or leukoplakia in syphilis of the central nervous system or in late cutaneous syphilis.

The chancre seen on the lips is not tender and usually does not concern the patient. It does not pustulate unless it is a mixed soft chancre, and develops submaxillary or submental glands, or both. (Fig. 6.) These glands likewise are not tender and do not soften and discharge, but gradually disappear with or without therapy. The mucous patch is not tender, in contrast with the canker sore which is exquisitely tender but is not associated with adenopathy and heals spontaneously, only to recur at a later date. The gumma may produce a huge enlargement of the tongue making mastication difficult or impossible. (Fig. 7.) All these

6 7

FIG. 6. Chancre of the lip. Bilateral submaxillary glands are well shown.

FIG. 7. Gumma of the tongue which had been treated intensively with the roentgen ray prior to observation under the mistaken diagnosis of cancer.

manifestations respond to therapy but leukoplakia alone is resistant to antisyphilis therapy.

The diagnosis of chancre is best made by the dark field microscope. Until fairly recently almost all pictures of Spirochaeta pallida were drawings. Inasmuch as the organisms are motile, the old-time photographic emulsions were too slow to stop the motion, and in the course of twenty-four hours, although the organisms had lost motility, they had degenerated to the point of losing their form. I conceived the idea of running a 10 per cent solution of formaldehyde under the cover slip, thereby stopping the motion and making a permanent mount. (Fig. 8.)

Streptococci and monilia are the two pathogens most commonly encountered in the buccal mucosa. It is interesting to me that they are frequently found in an equal degree in cultures of a given case, and it is difficult to determine which is the predominant pathogen. In a brain broth culture, I have seen the long chains of streptococci coiled around the spores of monilia-like serpents. The two organisms are obviously synergistic and treatment directed against both will usually be necessary. Cellulitis of the lower lip was a pronounced feature in a patient who was hospitalized because of high fever and leukocytosis. The mucosa was so involved that the patient could take only liquids.

Labial commissural dermatoses are frequently seen in persons past middle age. They may be symmetric or asymmetric depending on the tendency of the patient to sleep more on one side than the other. The tissues in these persons are relaxed and the patient tends to drool during sleep. As stated previously, brain broth and blood agar cultures show both streptococci and monilia organisms to be present. It is again difficult to assign the principal role to one pathogen. Usually I find that

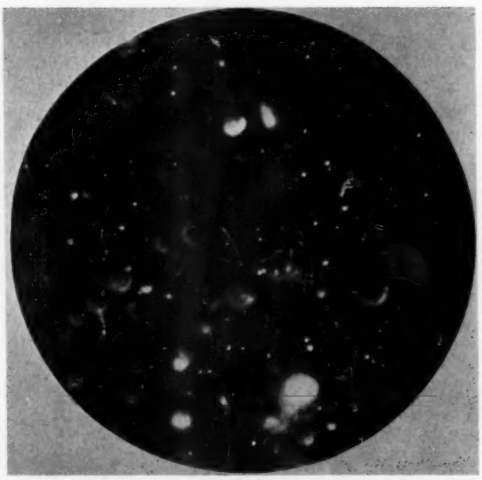


FIG. 8. Spirochaeta pallida in the dark field preparation made with formaldehyde.

9 10

FIG. 9. Geographic tongue.

FIG. 10. Scrotal tongue with moniliasis.

the preceding medical advisor has pronounced the condition due to avitaminosis but that therapy with large doses of vitamins has failed. Cultures, sensitivity tests and indicated topical treatment are usually necessary to bring about satisfactory results.

A disorder of the tongue often seen, which causes much concern to the victim, is the geographic tongue. (Fig. 9.) The efficient work of the American Cancer Society, however, has alerted these patients to seek medical advice. The etiology has never been determined. It is a harmless nuisance but can be alleviated to a degree by superficial x-ray therapy and local applications. It is a disorder usually seen in patients of middle age or beyond but I once diagnosed the condition in a three year old girl.

The fissured tongue is a congenital condition seen not infrequently, as is the scrotal tongue which is also congenital. (Fig. 10.) In the latter there may be a monilial infection at the back of the tongue.

SUMMARY

An illustrated discussion of the disorders affecting the buccal mucosa is presented. The disorders include benign and malignant neoplasms, buccal manifestations of systemic diseases, and local infections by streptococci, monilia and S. pallida. Included also are some disorders of unknown etiology.

Systemic Factors in the Etiology of Oral Lesions

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THE generalized statement can be made that systemic factors play a certain role in every oral lesion, if not strictly as primary etiologic factors, then certainly as modifying and aggravating factors.

Many of the lesions of the oral mucous membrane (exclusive of neoplastic lesions) have an obscure or idiopathic etiology and diagnosis is often made more difficult by superimposed secondary infection and inflammation. The inflammatory sequence can almost be considered as a usual event, knowing the nature of the oral environment.

Only by a very systematic, step-by-step study, can a diagnosis be made. As in most diagnostic procedures, a careful medical history must be taken. This should include recent laboratory findings with regard to the differential blood count, tests of kidney function, blood chemistry, complete urinalysis, glucose tolerance tests, etc. The subjective symptoms and objective signs should be well documented and a proper biopsy should be performed. Thus, the final differentiation of the condition can be reached.

The diseases of the oral mucous membrane are classified under clinical as well as etiologic subdivisions. The clinical classification subdivides them as follows: (1) white lesions, (2) bullous lesions, (3) ulcerative lesions, (4) epulides (tumors of the gingiva), and (5) according to color or localization. This is a very helpful classification as it reduces the number of possible lesions. We have found [1] that out of about seventy oral lesions, there are only eight which appear as white patches (leukoplakia); only eight with bullous characteristics; only four different epulides; and only about twelve which show ulceration and some of these symptoms often overlap each other.

According to etiologic factors, six groups have been created to classify the seventy different lesions, as follows: (1) Infectious diseases—bacterial, mycotic and viral diseases; (2) noninfectious diseases—inflammatory, dystrophic and congenital diseases (this is a large group of diseases including some of the most important oral lesions); (3) diseases arising from metabolic and endocrinic disturbances—diabetes, Addison's disease, pregnancy and disturbances of the reticuloendothelial system, such as eosinophilic granuloma or Hand-Schüller-Christian disease; (4) nutritional and dietary conditions, such as vitamin deficiencies, especially deficiencies of vitamin B and vitamin C, which under severe circumstances can lead to considerable disturbances of the oral mucous membrane but are very seldom seen as isolated oral lesions (they are more commonly secondary factors in a more generalized disturbance); (5) lesions produced by chemical or physical injuries; and (6) oral manifestations of disturbances of the blood-forming organs. In this group are included disturbances of the red blood cells such as anemias and polycythemia; diseases of the white cells such as neutropenia and the leukemias. Thrombocytopenic purpura and hemophilia are also classified in this group.

This classification is far from being perfect. In fact, there is possibly no perfect classification, especially of such a great variety of diseases as can be seen in the oral cavity. However, a classification is only designed as an aid in making a diagnosis and in placing the disease into a certain category (a filing cabinet). Without such a filing cabinet, the various diseases would produce confusion and create greater difficulties in proper therapy. It is evident that this classification is based on etiology as well as pathologic changes of tissues, and also upon the clinical features.

Systemic factors, such as susceptibility or immunity, and constitutional factors play a role in almost every one of the seventy diseases, and consideration of the systemic status of the patient is an essential factor in proper management of the disease.

The etiology of many of these diseases might be idiopathic but the pathogenesis is often well understood and must serve as the guide in the planning of treatment. It is not true that therapy should not be undertaken because the etiology is unknown. There are many diseases of unknown etiology which have been treated successfully with empirical methods. One of these diseases, taken as an example, is eosinophilic granuloma. The etiology of this disease is unknown but it can be successfully treated by proper roentgenological therapy.

In the diagnosis and treatment of oral lesions, it is most important that the whole patient be taken into consideration.

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Technical Clarification of the Bone-Flap Method in Surgery for Cleft Palate

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THE bone-flap method in surgery for cleft palate may be used as early as the ninth month in infants of normal development. Surgery on the palate should be performed so that complete closure can be obtained before the child learns to speak. This will help avoid the acquisition of poor speech habits during the early formative period. It is known now that the acquirement of speech habits begins early in the second year and continues during the entire childhood.

In surgery on an older child there is the possibility that the characteristics of speech could remain almost unchanged. The patient may have learned to use substitute mechanisms which are inadequate as compared to the natural mechanism of speech.

Narrowing of the width of the palate is not secondary to early surgery on the palate if the bone-flap technic is used. This has been indicated by examination of study casts and cephalometric x-rays, as previously reported. The bone flap technic as used in patients with unilateral clefts of the palate repaired between nine and eighteen months of age has been reviewed in *The American Journal of Surgery*.* This study has shown: (1) The intermolar width between the first permanent molars was within normal limits as determined by its occlusal relationship with the lower molars. (2) The first permanent molar on the side of the cleft was in medial version or class two relationship with the lower molar on that side. (3) The teeth anterior to the first permanent molar on the side of the cleft were in lingual cross-bite relation with the mandibular teeth. (4) The incisor teeth in both segments were in lingual cross-bite in a number of patients. (5) The teeth next to the cleft were rotated and tipped toward the cleft. The anterior cross-bite is indicative of the rotation of the bony segments by labial muscular action of the repaired lip and is not due to the growth disturbance subsequent to the palatal repair.

This is clinically supported in the view of a ten month old baby's palate showing the overlapping of the alveolus. (Fig. 1.) The palate had not yet been operated upon. The alveolar cleft was wide in conjunction with a third degree cleft lip and cleft palate. Within a few months following the repair of the cleft lip, the muscle action of the lip across the alveolar cleft had narrowed the anterior cleft and had actually caused closure with an anterior cross bite. When the teeth erupt in this child, there will be rotation and tipping of the teeth next to the alveolar cleft due to the lack of supporting tissue in this area. This cross-bite of teeth anterior to the first permanent molars will be later amenable to orthodontic correction.

Further study should be given to intercepting this situation early, if possible, with some form of palatal plan to control or counteract this undue labial muscular action. The anterior

FIG. 1. A previously wide alveolar cleft that has been closed by muscle action of the repaired lip.

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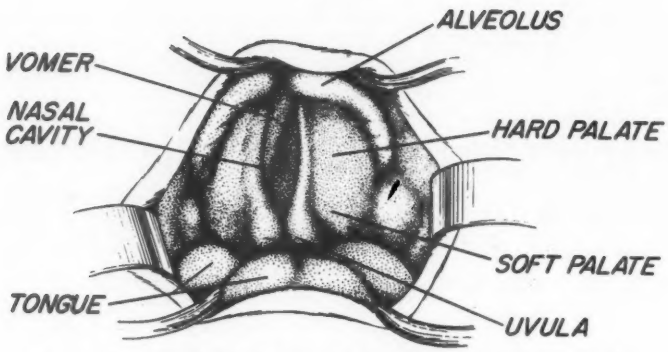

FIG. 2. Complete cleft palate with designated anatomical landmarks.

narrowing of the palate secondary to the action of the labial musculature should not be blamed on palatal surgery. Many patients who have never had palatal surgery show this same type of anterior palatal and alveolar picture.

One should remember that no operation is better than the surgeon performing it; before an attempt is made to perform this bone-flap operation, one should make every effort actually to see the operation performed.

The following series of diagrams are presented for clarification of the technic employed:

Figure 2 illustrates a complete cleft lip and cleft palate. It is interesting to note how the pull of the palatal musculature brings together the posterior elements of the palate. This may help to account for the good healing usually accomplished in the bone-flap operation. When the bone is actually separated on each side of the alveolar border, the muscle pull with loosened bone flaps helps accomplish a satisfactory closure if good approximation is obtained.

Figure 3 illustrates the incisions. These are made inside the alveolar border in an anterior posterior direction, starting around and behind the tuberosity of the superior maxilla on each side and extending forward approximately three-fourths the length of the hard palate. This line of incision is kept just inside the alveolar ridge in infants. Chisels are then introduced usually in series.

Figures 4A and B illustrate the first chisel below, dividing the hamulus process in the perpendicular and infracturing the mesial segment. The chisels anterior to this actually fracture the palatal process medialward and bring it in contact with the opposite process. When moving these flaps toward the midline, leverage pressure should not be applied upon the alveolar ridge. This will avoid injury to the teeth, unerupted or otherwise.

Figure 5 illustrates the treatment of the edges of the palatal cleft. (1) Actual stripping of the mucous membrane along the entire edge of the palatal cleft to be approximated is

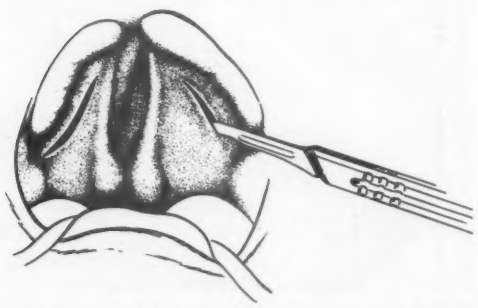

FIG. 3. Lines of incision just inside the alveolar ridges.

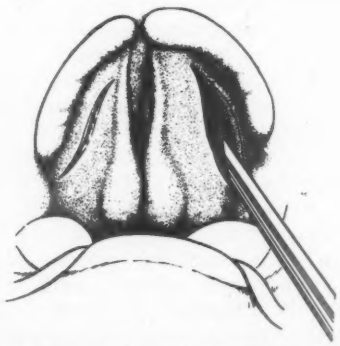

FIG. 4A. Position of first chisel beginning division of palatal bone and hamulus.

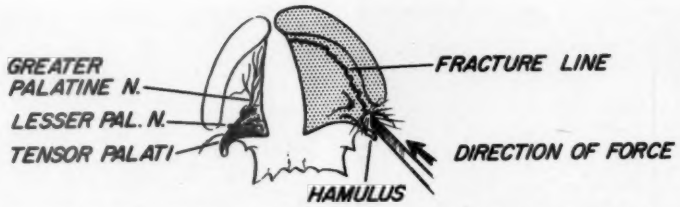

FIG. 4B. Fracture line in palatal bone and its relationship to greater palatine nerve and artery. The hamulus is divided perpendicularly and the medial segment is fractured toward the midlines.

performed and (2) a knife is then introduced halfway between the nasal and oral side of the palate. The stripped edge is pared to produce a nasal and oral side. The paring incision is made 2 mm. in depth down the entire length of the palate to give increased width to the edge. It should be noted at this time that plain gauze packs are placed in the lateral incisions to control hemorrhaging which is usually not troublesome unless the greater palatine artery is severed. This also can be controlled by packing. The palatal packing helps hold the flaps in the new medial position during the suturing.

Figure 6 illustrates the approximation of the edges of the palate. The first suture is placed immediately posterior to the junction between the soft and hard palate. Number 3–0 nylon suture is used. Half the thickness of the palate is penetrated as illustrated in the most anterior suture of the diagram, because the nasal side of the palate will fall together by merely tying together the suture of the oral side. This will help prevent the formation of fistulas that could be produced by through and through suture. These sutures are placed between a quarter and an eighth of an inch all the way to the tip of the uvula. One suture is placed on the nasal side of the uvula for better approximation. In the bilateral total cleft palate it is found that usually only the posterior two-thirds or seven-eighths can be closed. Total closure can be performed in less severe palatal types. Following complete suturing and cutting of the sutures, gauze packs impregnated with Furacin® are then placed into the lateral incisions to relieve tension on the suture line and control bleeding. These packs have tape gauze tied to them. The knot end on the tape gauze is introduced into the incision first so that if the packing should happen to become loose the child could not choke on the end of the packing in the throat. This tape gauze is then brought out to the cheek and taped thereon. (Fig. 7.) The packs are left in position for a period of five days. The operative time is considerably shorter with the bone-flap operation than with any other technic.

Figure 8 illustrates dissection of the cleft

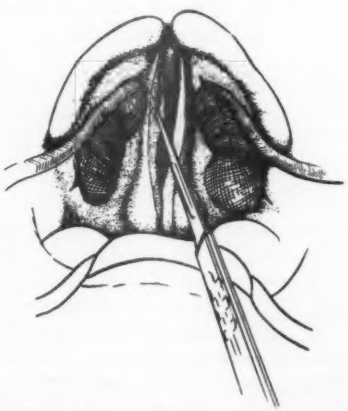

FIG. 5. The edges of the palate are stripped of mucous membrane and incised halfway between the nasal and oral surfaces. Plain gauze packs are placed in lateral incisions to control hemorrhage and to help hold the flaps together during the suturing.

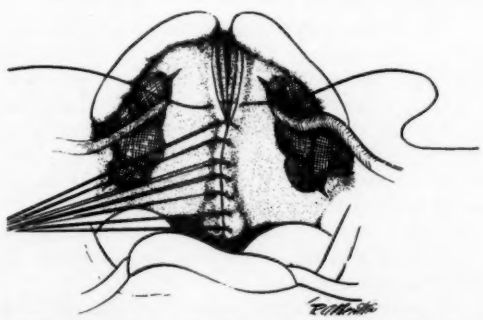

FIG. 6. Sutures are placed so that only the oral half of the thickness of the palate is penetrated. These sutures will approximate the entire thickness of the palate.

FIG. 7. The gauze tape that has been inserted in the lateral incisions is led out through the mouth and taped to the cheeks.

FIG. 8. Dissection of a cleft palate in a stillborn. This illustrates that the greater palatine artery and nerve are located medially to the proposed fracture line. They will not be damaged during surgery.

palate in a stillborn. It brings out the fact that the greater palatine artery and nerve are located medial enough in the cleft palate so that these structures are usually not disturbed during the described procedure.

Postoperatively the child is given 400,000 units of penicillin daily until the packs are removed. Twenty-four to forty-eight hours following removal of the packs it is noted that the areas of the lateral incision fill up with granulation tissue. By the tenth postoperative day these granulations are usually covered over with mucous membrane level with the palate. The sutures are removed on the fourteenth postoperative day and by this time many of the palates are completely healed over. The children are given clear liquids for the first five days and a soft diet for the next two weeks. Following removal of the sutures on the fourteenth postoperative day the child is discharged from the hospital.

If a second stage is necessary, a period of at least three months should elapse between the first and second operations. At the second stage the mucoperiosteal flap technic is used for the small anterior openings. Here it is merely a matter of raising mucoperiosteum in the anterior portion of the palate and starting it over from alveolar incisions anteriorly. There are many other methods also available for more difficult types of closures when there is a shortage of tissue.

It should be noted that when palates are closed in single operations, the children may (in some cases) have some difficulty in breathing until such time as they become adjusted to the smaller airway. It may take a period of twenty-four to forty-eight hours.

It may be noted in the series of diagrams that there was no perceptible shortening of the soft palate. As a matter of fact, it appears that the palate becomes lengthened following the bone-flap movement toward the midline. The postoperative result yields a longer, more flexible soft palate. The function of the speech mechanism can be expected to be more nearly normal. Hemorrhage during surgery is easily controlled and the operation may be stopped at any time if the patient's condition becomes unsatisfactory without endangering the end result. There is no broad surface scarring over the palatal bone as there might be with a von Langenbeck mucoperiosteal type of procedure to interfere with the growth of the palatal bones. The operative time is minimal and therefore there is less surgical shock involved.

CONCLUSIONS

The bone-flap technic in surgery for cleft palate provides a simple relatively safe procedure for reconstruction of the cleft palate. A new bony vault is restored to the roof of the mouth as nature originally intended. The eventual results in the speech of the child are superior to other methods used.

Acknowledgment: I wish to thank Mr. R. Albertin of Marquette University Medical Illustration for the excellent painstaking stippled diagrams.

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Anatomical Considerations in the Surgical Management of the Cleft Muscular Velopharynx

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THE production of sound in the form of speech requires one of the most highly integrated muscle groups in the human body, namely, the muscular velopharynx. In actually viewing the velopharyngeal muscles in the act of producing speech, one can see why some of their more complicated patterns still baffle speech physiologists.

The congenitally split velum presents two anomalies which make the difference between good speech production and the distorted patterns associated with this malformation:

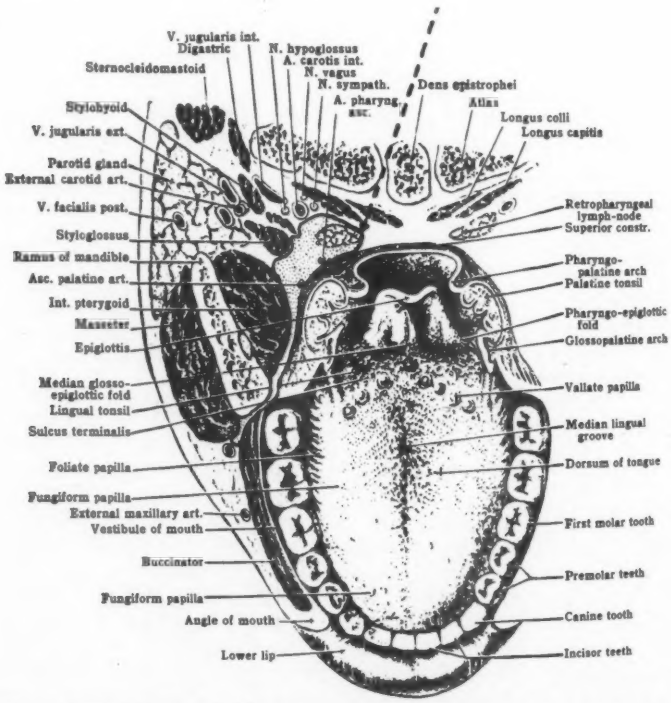

FIG. 1. Broken line indicates horizontal section through head at level of angle of lips demonstrating anatomical relation of superior constrictor of pharynx and surrounding lateral pharyngeal space (right). (Figures 1 through 5 from: BEAVIS, J. O. Lateral pharyngeal space dissection as an adjunct in reconstructing the muscular velopharynx. *The Laryngoscope*, 64: 754–771, 1954.)

first, a widened bony and muscular pharyngeal vault containing two separate anatomical entities which cannot act physiologically until built into one composite mechanism, a velopharyngeal sphincter; and second, degenerative changes including atrophy and hypoplasia of all or part of the soft tissues and skeletal structures comprising the palatovelar architecture. These changes begin when the component parts of the palate fail to unite in intrauterine life and continue because of distorted physiology. Fortunately for the surgeon, the muscle groups which comprise the normal velum and those of the split velum are essentially the same. This is also true of the nerve and blood supply.

By recognizing that the mesopharynx in this malformation is widened in both the anteroposterior and the lateral diameters, and that the musculature of the velopharynx must be reassembled into a position in which it can function more physiologically, its surgical anatomy must be considered.

The musculature of the velopharyngeal sphincter together with its nerve and blood supply lies within the dome of the pharyngeal tube. With the exception of the tensors, the sphincter is almost completely enveloped by two of its most important components, the superior constrictors of the pharynx. In enumerating its anatomical boundaries, one has only to outline those of the superior constrictors. (Fig. 1.) Above, the constrictors are literally hung from the base of the skull by their fascial attachments. (Fig. 2.) They are bounded laterally by the pharyngomaxillary fossae or lateral pharyngeal spaces. (Fig. 3.) Their points of origin include the posterior border of the horizontal plate of the palatine bones, the lower third of the medial pterygoid plates and their hamuli, the pterygomandibular ligaments, the alveolar processes of the mandible and fibers from each side of the tongue.

With the velopharyngeal muscular mechanism so outlined anatomically, it at once becomes apparent to the surgeon that by freeing the superior constrictors from their bony, ligamentous and musculofascial attachments, and by dissecting free their surrounding lateral pharyngeal spaces, complete mobilization of the muscular components with their nerve supply may be attained.

The entry to either lateral pharyngeal space is made by splitting one of the most important

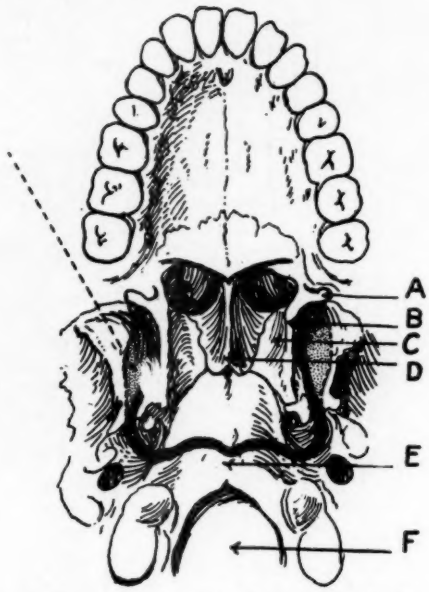

FIG. 2. Heavy line shows attachment of fascia pharyngobasilars to base of skull. A, hamular process; B, pterygoid plate, C, sphenoid bone, D, vomer. E, occipital bone. F, foramen magnum. Broken line indicates position of lateral pharyngeal spaces in relation to base of skull.

ligamentous suspensory attachments of the velum, namely, the pterygomandibular raphe. Once this is done, the anterosuperior aspect of the lateral pharyngeal space lies open so that the rest of the space can be ablated by blunt dissection. By this method the nerve supply to the tensor, which enters that muscle in its upper third, is not cut or even traumatized. (Fig. 4.) The same may be said of the motor innervation of the remaining muscles of the velum. Figure 5 demonstrates the exit of the glossopharyngeal, vagus and accessory nerves from the carotid sheath, high in the neck and posterior to the lateral pharyngeal space. Careful dissection eliminates any possibility of interfering with the function of these nerve elements which make up the pharyngeal plexus.

In dissecting the lateral pharyngeal spaces one should keep in mind that the blood supply in this area is composed of two vessels: one is the ascending palatine artery, which traverses vertically upward over the superior constrictor and occupies an anterior position in the fossa;

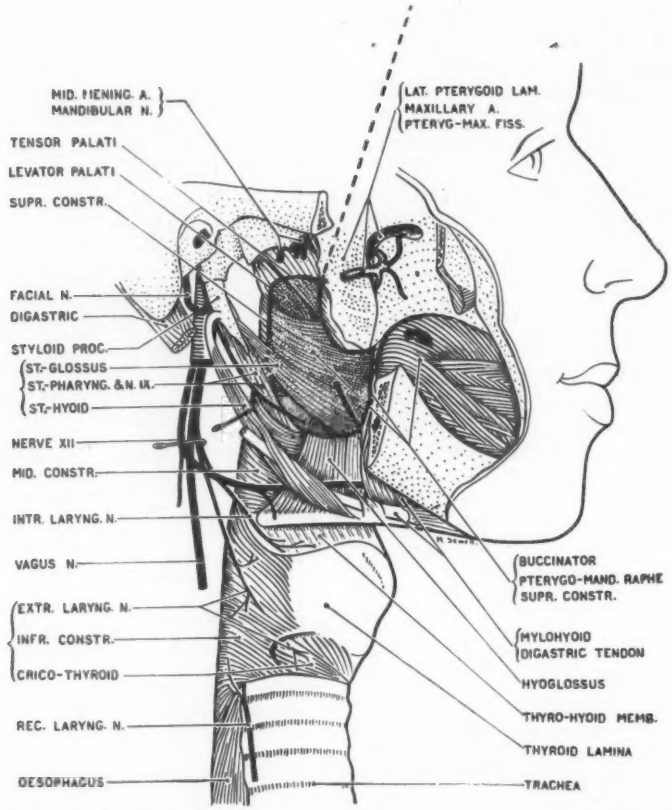

FIG. 3. Broken line indicates lateral and posterolateral aspects of right lateral pharyngeal space to muscles of velopharynx.

the other is the ascending pharyngeal, which lies over the muscle and is also vertically directed upward but in a posterior position. In our experience, careful manipulation of the tissues prevents damage to these vessels and thereby obviates excessive bleeding.

The lines of incision chosen for dissection of the tissues of the hard palate resemble those described by von Langenbeck [2] in the latter part of the nineteenth century. The tissues of the hard palate are elevated in their anterior extremity and the dissection is continued in a posterior direction. After identifying the greater palatine vessels, the dissection is extended posteriorly until the pterygoid hamulus is exposed and severed. If at this point the pterygomandibular ligament is split from before backwards, the dome of the pharyngomaxillary fossa, or lateral pharyngeal space, will be opened and easy access may be gained to perform blunt dissection of the fossa. By so doing, the component "muscle block" of the velopharynx on the dissected side will be freed, so that when the rest of the dissection is completed it will assume a relatively normal anatomical position. Following dissection of the fossa, the attachments of the superior constrictor to the posterior border of the horizontal plate of the palatine bone and the lower third of the medial pterygoid plate are severed. This maneuver allows the surgeon to elevate the greater palatine vessels from their bed in the pterygopalatine canal, so that when transfixation takes place an adequate blood supply is assured.

With the lateral dimension of the muscular velopharynx dissected free, it has been our plan not only to cross hatch but also to de-

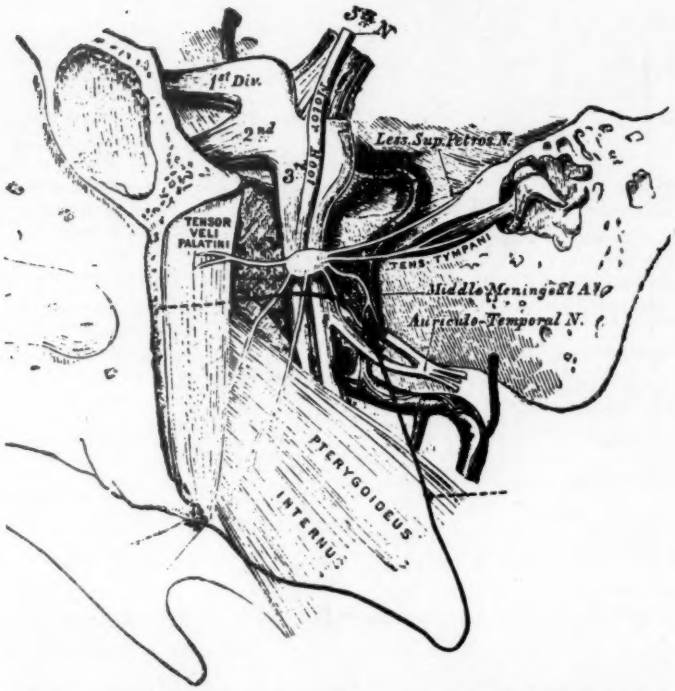

FIG. 4. Lower broken line indicates relative anatomical position of lateral pharyngeal space and its relation to nerve supply of tensor veli palatini.

epithelize completely the mesial surface of this muscle group; then upon transfixation the split blocks of muscles can unite into one integral unit which, after healing, can function physiologically.

Having completed dissection of one side of the velum, the lateral pharyngeal space is gently packed with dry gauze and the contralateral side is handled surgically in the same manner.

When the dissection of both halves of the velum is completed and the lateral pharyngeal spaces are opened widely, it becomes apparent that the whole muscular velum can be transfixed through the lateral pharyngeal spaces. Working in these anatomical spaces permits the surgeon to unite more perfectly the two muscle blocks that are eventually going to form a functioning palatopharyngeal sphincter. For this purpose we have routinely used through and through sutures of No. 0 chromic catgut. With the muscular velum transfixed, the lateral pharyngeal spaces stand wide open. It has been our practice simply to pack them lightly with oxycellulose gauze to control any oozing which may occur following surgery. These spaces are not touched afterward and usually have healed by granulation within a period of two weeks following the operation.

We have consistently dissected the lateral pharyngeal spaces when performing retroposing procedures on the velum. In dealing with congenitally short palates, or those presenting a submucous cleft, we have found that this method lends itself admirably to the transposing technic. The same principle also applies to those patients who have been operated upon previously with failure and in whom there is considerable scar tissue with shortening of the velum.

SUMMARY AND CONCLUSIONS

An attempt has been made to throw into sharper focus the importance of the anatomical position of the muscles, nerves and blood supply of the velopharynx and its surrounding pharyngeal spaces. It has been our experience

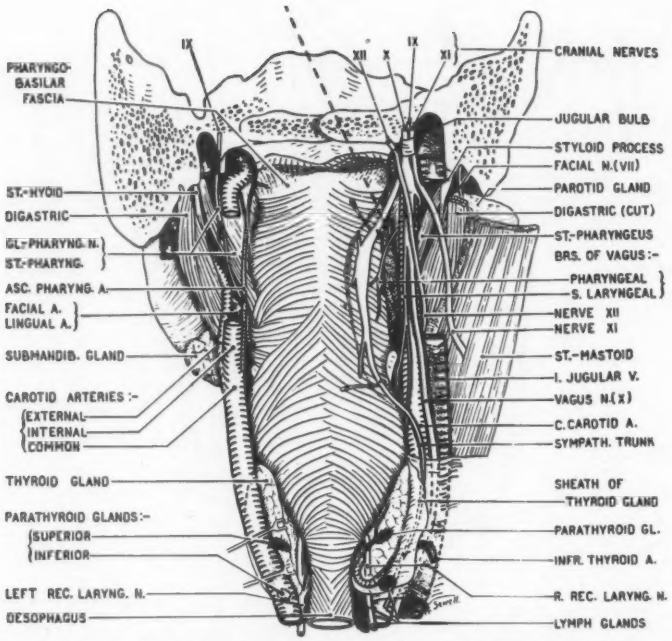

FIG. 5. Broken line indicates posterior dimension of lateral pharyngeal space, showing its relation to motor nerve supply of muscles of velopharynx.

that by a more complete anatomical understanding of these structures, the surgical approach to their reconstruction through the lateral pharyngeal spaces has assured us of functional results that far surpass those obtained in the past.

How pertinent were the remarks of Franz Ernst when, in 1917, he wrote, "If one strives to eliminate obturators, then a circular narrowing of the pharynx is required to such an extent that the function of the muscles is sufficient to close the opening between the nose and mouth. In most cases, such a narrowing of the pharynx is sufficient" [3].

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The Vomar Flap

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THE object of any therapeutic procedure upon a congenitally crippled person is to correct the congenital abnormality in such a way that the affliction may be resolved without producing further physical or functional stigmas.

In the case of congenital clefts involving the bony palate, any therapeutic procedure should have three objectives: first, closure of the palate; second, restoration of the normal mechanics of speech; and third, insurance of normal growth of the maxillary and facial bones. Any operative procedure that does not accomplish all three objectives is not a proper one.

In the past, it has been all too apparent that the various technics used, strove to accomplish the first and the second objectives with little or no consideration for the third. This was so universal that the typical dished-in, contracted, postsurgical facies of an adult with cleft palate was accepted by many surgeons as the norm. Years of orthodontia were spent trying to give the child a normal dental

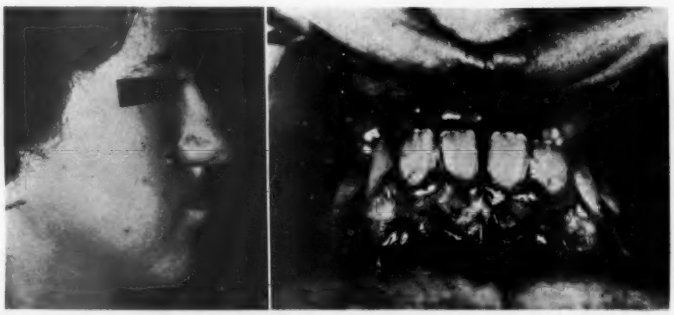

FIG. 1. A thirteen year old girl with cleft palate showing marked lack of development of the upper jaw and facial bones as a result of surgical interference.

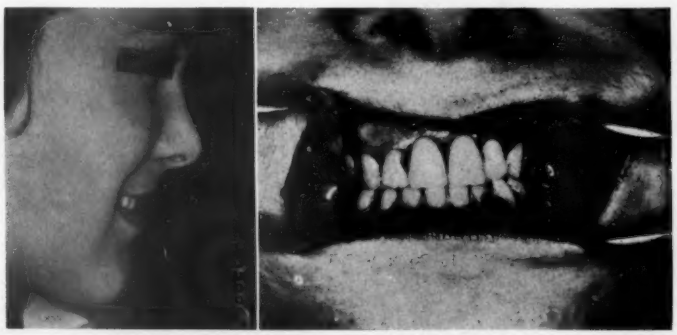

FIG. 2. A twenty year old girl with cleft palate who had never been operated upon showing normally developed upper jaw and facial bones.

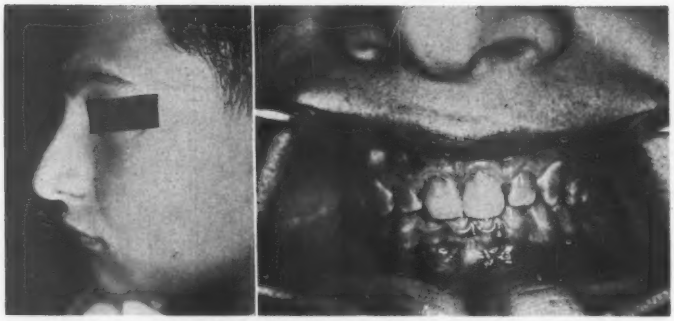

FIG. 3. A fourteen year old boy with cleft palate operated upon by the vomar flap technic with full development of the upper jaw and facial bones.

arch, which is impossible in a stunted maxilla. The maxilla was stunted by surgery, not by any intrinsic factor in the original deformity. The basic cause of this is the introduction of scar tissue subperiosteally, which occurs in the von Langenbeck operation and its modifications.

The stunted maxilla often created a worse deformity than the original defect, as in the patient in Figure 1. I have seen adults who had never been operated upon, as in the patient in Figure 2, who were infinitely better off and far better able to adjust themselves to society than their contemporaries who had undergone surgery. Their facies looked the

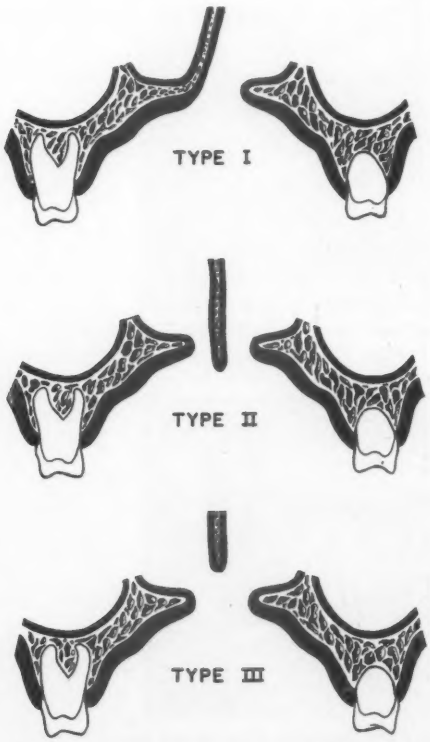

FIG. 4. The three types of vomars encountered.

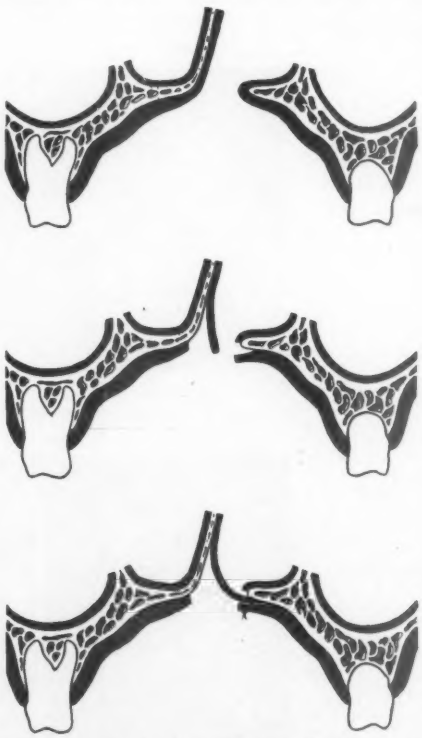

FIG. 5. Schematic drawing of closure of type I in which the vomar mucous membrane is elevated from the underlying vomar bone and sutured to the other side of the cleft, closing the defect.

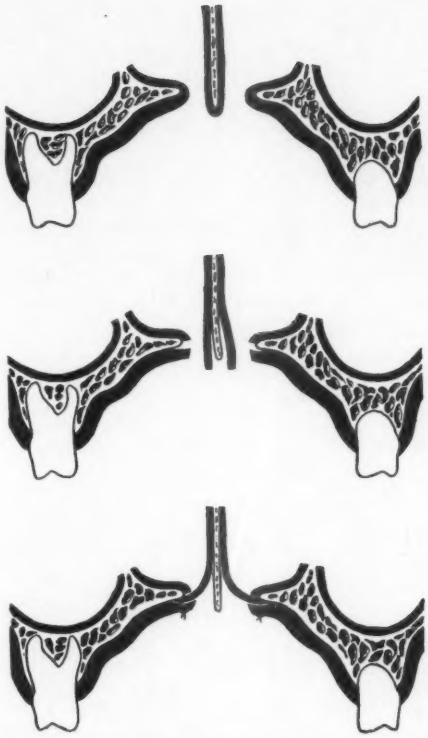

FIG. 6. Schematic drawing of closure of type II in which the vomar is split in the midline and sutured to the cleft margins on each side.

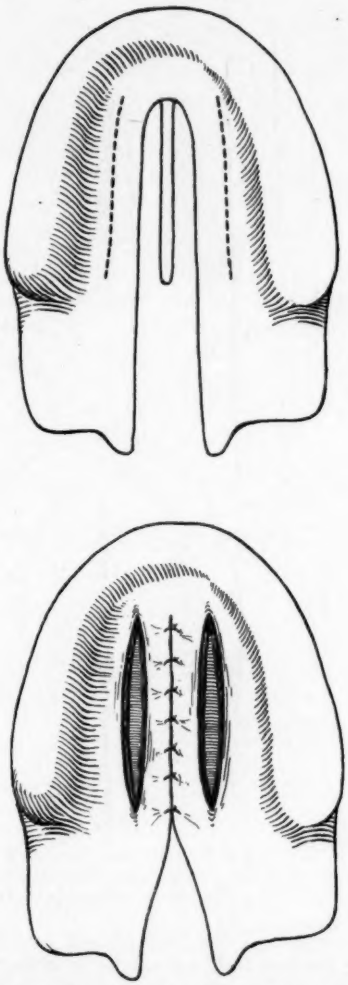

FIG. 7. Schematic drawing of type III closure in which sliding flaps are used from ¼ to ⅜ inch in width to close the defect, keeping well away from the junction of the alveolar process and palatal bone.

way nature intended. It is a well known fact that the cleft palate which has not been operated upon develops its maxilla and facial bones normally, showing those surgeons to be incorrect who for years have maintained that the gross appearance of these adults was due to some intrinsic factor in the cleft deformity.

Any technic in which this last objective is not observed is both inadequate and destructive. Some men try to accomplish this by delaying closure of the hard palate until the child is old enough to have obtained a large percentage of the growth of the upper jaw. The upper jaw does not stop growing until some time after the age of sixteen. Therefore, if the operation is delayed until the fifth, sixth or seventh years of age and then performed, some growth will still be impaired, and the child will have unnecessarily spent several years with a hole in the roof of his mouth.

The only way I know of closing the defect in the hard palate at a reasonably early age without causing loss of growth of the maxilla and facial bones is by the vomar flap technic. (Fig. 3.) A practical and workable way of classifying patients with cleft palate is by the size and position of the vomar. Classifications based on embryology are academic and of little use to the operating surgeon.

Figure 4 shows the three types of vomar encountered. In type I, the vomar is continous with one side or the other of the hard

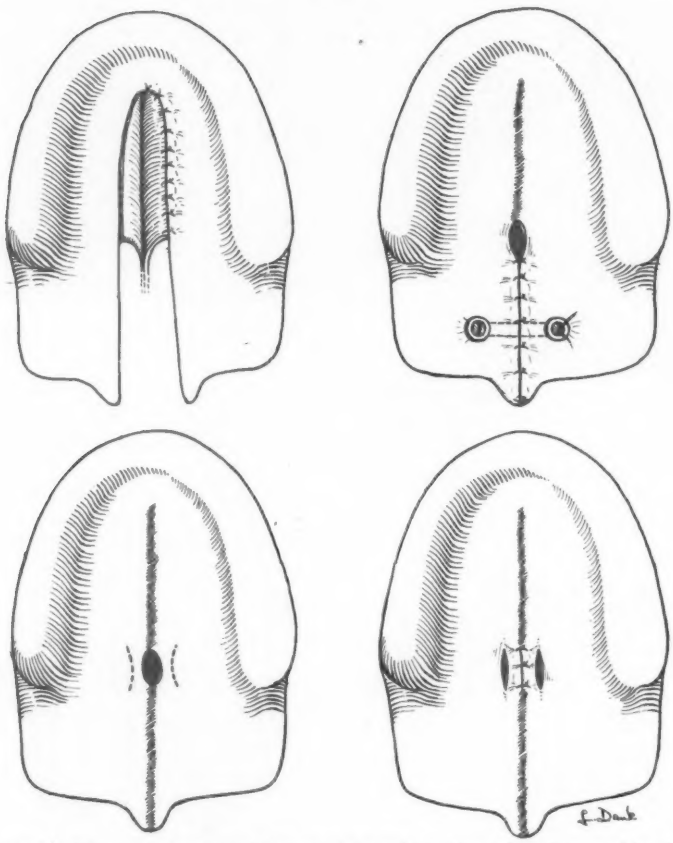

FIG. 8. Schematic drawing of closure of the palate. *Upper left*, closure of hard palate by vomar flap. *Upper right*, closure of the soft palate. *Bottom*, closure of the junctional area between the hard and soft palates.

palate. (Fig. 5.) In type II, the vomar lies free in the mouth but extends far enough into the oral cavity so that the mucous membrane, if split in the midline, will extend laterally to each side of the palatal cleft. (Fig. 6.) In type III, the vomar is so short that the mucous membrane, if split in the midline, cannot possibly reach the cleft edges.

In the past eight years since my first description I have changed the technic in this third type. It was found that during the years following closure of the palate, by inverting the flaps from above downward (as described in a previous paper*), some of these would perforate for lack of an adequate blood supply. Consequently, this third type of cleft has been closed by using sliding flaps, ¼ to ⅜ inch in width, as illustrated in Figure 7. It has never been necessary to use flaps more than ⅜ inch wide. Flaps taken close to the edge of the cleft apparently have no effect on the growth of the maxilla, as I have in no case observed any stunting in the upper jaw in patients so treated. This would lead to the conclusion that growth probably takes place close to the junction of the palatal bone and the alveolar process.

After the hard palatal portion of the cleft is closed, the soft palate is closed at some subsequent time without undermining the tissues. It is rarely necessary to incise the nasal aponeurosis at the posterior edge of the palate, but occasionally ¼ inch flaps must be used to

* DUNN, F. S. Management of cleft palate cases involving the hard palate so as not to interfere with the growth of the maxilla. *Plast. & Reconstruct Surg.*, 9: 108–114, 1952.

close the junction of the hard and soft palate. (Fig. 8.) Closure of the soft palate can be performed at the time of the closure of the hard palate but it is safer from the standpoint of tissue survival to separate these two procedures.

Surgery utilizing the vomar flap technic is followed by practically no shock to the child, in contrast to operations performed by modified von Langenbeck technics. A minimum of orthodontia is required, usually being limited to the teeth in the immediate area of the cleft, passing through the alveolar process. The soft palate is soft and flexible and the palatal arch provides a proper bed for the tongue, so necessary for phonation.

In conclusion, I believe that the vomar flap technic is the operation of choice in clefts involving the hard palate; it accomplishes our original objectives with a minimum of scar tissue by providing closure of the palate, the mechanics of good speech, and in no way interfering with the growth of the maxilla and facial bones. The mouth can be restored to a relatively normal condition at two or three years of age when the child is learning to speak; and the child can be assured of growing to adulthood with a face that nature intended.

Medical Hypnosis in Maxillofacial and Plastic Surgery

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ON the icy night of January 11, 1958, a car skidded, and P. H., an eighteen year old girl, found herself facing the prospects of a long emergency operation to suture the extensive lacerations of her face. She had eaten an hour before and could not have the benefit of a general anesthetic. Thoughts of an operation under local anesthesia only aggravated her hysteria. As the extent of the injuries was being determined, advantage was taken of her disturbed state, and a hypnotic trance was developed; posthypnotic suggestions of the operation to follow and the ease with which it was to be performed were given. This, then, laid the groundwork for the four-hour operation, during which the facial nerve and lacerations of the skin were sutured. The four hours seemed like one to the patient, as she, in her hypnotic trance, saw green mountains on a beautiful spring day and with her finger tapped the rhythm of relaxing music.

Hypnosis had its start in early civilization in the use of suggestion by medicine men and witch doctors. In Biblical times, "temple sleep" and in the middle ages, "laying on of hands" were used in suggestion therapy and resulted in "miracle cures." Mesmer in the late seventeen hundreds popularized "magnetism," and Braid in the middle eighteen hundreds obtained a sleep response by concentrating the patient's attention with eye fixation and called it "hypnosis." Its use in anesthesia and psychoanalysis was further developed in Europe and America by such men as Liebeault, Bernheim, Bruer and Freud. World Wars I and II further stimulated its use for medical and dental purposes, both in psychotherapy and anesthesia. The British Society of Medical Hypnotists was founded in 1948. In the United States in 1949, The Society for Clinical and Experimental Hypnosis and The American Society of Psychosomatic Dentistry were formed. These were followed by other national and local societies to develop the use of hypnosis by physicians, dentists and psychologists [1].

The moment a doctor recognizes his patient as an individual and exhibits a personal and sympathetic interest in his complaint, the patient is open to suggestion and can be easily conditioned to elicit some motor, sensory or intellectual response consistent with his health problem. Thus, the interpersonal relationship between patient and doctor is established. Prestige is the first step in so conditioning a patient, and in the case of a specialist, this is usually created by the referring doctor or a satisfied patient. With rapport established, the doctor (presenting logical suggestions satisfying the health needs and interests of the patient), has no difficulty in achieving the desired psychic phenomena to accompany his medication or treatment. The art of suggestion and the establishment of rapport are therefore basic in the practice of medicine and dentistry. When, however, does suggestion end and hypnosis begin? Actually, the transition from suggestion to hypnosis is a matter of degree and depends upon the needs and motivation of the patient, supplemented by his suggestibility and dominated by the prestige factor of the doctor-patient relationship. To be effective, however, the suggestion and hypnotic phenomena must satisfy the patient's health and psychic needs [2].

Hypnosis actually is a state of increased suggestibility accompanied by an interpersonal rapport between the subject and the operator, during which the subject puts himself into a condition resembling sleep. In this condition, suggestions given by the operator are accepted

without reservation if they are presented logically.

Hypnoanesthesia for surgery is produced through a psychosomatic response at the suggestion of relaxation and anesthesia. The psychosomatic response to relaxation is developed in most contacts of doctor and patient to varying degrees and is usually referred to as "waking hypnosis." All doctors use this phenomenon when they take the history, perform a physical examination, announce the diagnosis and suggest the treatment, for when the patient's head starts to nod approval of the doctor's assertions, he or she is entering a state of trance. This simple observation indicates the patient's susceptibility to suggestion and hypnosis.

Unless a disguised approach should be made, it is best to help the patient develop a prehypnotic attitude, referred to as "mental conditioning" or "positive mind set," to hypnosis and what will be expected of him. This helps accentuate the patient's desire to please the operator, and the induction to the state of trance is more readily accepted. Many methods of induction are available and are used as indicated. Some of these are "eye fixation," "tension release" and "challenges." More disguised methods take advantage of natural phenomena, such as breathing, body movements or behavioral patterns. The technics of their use are not within the scope of this paper, and therefore I refer the reader to the various texts on hypnosis. Trance-deepening procedures are then employed until the somnambulistic or deep trance stage is reached. At this point, the patient has rhythmic breathing, keeps his eyes closed, has a fixed stare and dilated pupil, or has lost all coordination of the eyes. At this depth of trance, anesthesia is suggested and usually accepted. Visual and auditory hallucinations are developed for distraction; surgery is begun and posthypnotic suggestions are given, or psychoanalysis is undertaken [3,4]. The surgeon, however, should stay within his field and confine his uses to anesthesia and posthypnotic suggestions relative to an uncomplicated recovery.

Careful consideration should be given to the training of professional men who want to use hypnosis. It is a medical procedure and should be studied in medical or dental schools, or under qualified instructors as listed by the national and regional hypnosis societies. Experience has shown that greater proficiency in the use of hypnosis is developed when small study groups are taught on a personal basis, with the instructor helping each trainee with his first three or four cases. An examination and certification is given by most instructors. This is helpful because adequate training can be important in medical-legal issues and is recommended by insurance underwriters.

The psychic needs of the doctor or dentist applying the hypnotic technic must be considered. Many instructors of hypnosis require some form of psychological evaluation before acceptance for training. The hypnotic interpersonal relationship has as its basis the transference and countertransference phenomena; for example, the patient seeing the doctor as a mother, father, lover or godly figure, and the doctor seeing the patient as the image of what he wants to see in that patient. The usual hypnotic induction starts with the soothing lullaby of monotonous words and gestures of the "mother figure," then changes to the firm, authoritative challenges of the "father figure," and more often remains as the father figure throughout the state of trance. One must be careful because, through subliminal clues, the hypnotic patient will pick up an unconscious intimation of a thought and be offended, even though no physical contact is made. Therefore, as the doctor enters this interpersonal relationship, he must have his own neuroses under control.

In dentistry, hypnosis is used for anesthesia in operative and surgical procedures, and in orthodontics and prosthetics to help patients accept and wear appliances. Its anesthetic use in the specialties of medicine and surgery is yet to be fully explored. In obstetrics, labor is shortened and anesthesia is developed for delivery. Cesarean section and minor gynecological procedures are performed with the patient under hypnosis. Marmer recently reported on its use in cardiac surgery [5]. In plastic surgery, we believe its application extends even beyond its use in dentistry.

Hypnosis is of particular value in surgery about the head and neck, especially when a general anesthetic would be hazardous or contraindicated. Patients requiring (as a result of accidents) extensive suturing of facial lacerations or intermaxillary wiring of fractures of the mandible and maxilla do not have airway problems under hypnosis. For the same reason

hypnosis has been extremely helpful in surgery for cancer of the head and neck and reconstructive surgery. Other plastic procedures about the face, such as rhinoplasty, otoplasty and scar revision, are made much easier by developing a relaxed patient. The physical changes obtained by such surgery are completely acceptable on suggestion. Control of salivary secretions and reduction or increase in blood flow to a part are possible under hypnosis. Good anesthetic qualities and vascular control develop in the extremities and are helpful in surgery of the hand. Procedures requiring a change of position during an operation are easily handled by the patient under hypnosis, but are more complicated with the patient under general anesthesia (which requires an endotracheal tube and the physical effort of lifting and turning the patient). Changing of burn dressings, skin grafting of burns, and physiotherapy are all made much easier with the help of hypnosis. We have noted that the taking of a dermatome skin graft with the patient under spinal anesthesia is usually disturbing to a patient, but when hypnosis is added the patient experiences no sensation and does not move on the cutting of a graft. The treatment of a recently burned patient demonstrated this very well. Increasing the patient's appetite and the desire to get well are favorable conditions to develop with posthypnotic suggestions.

A surgeon will find hypnosis useful in other procedures, such as removing sutures in nervous adults and children, especially in patients with cleft palates. Postoperative splinting of a wound to reduce spread of the suture line is aided by suggestion. We have had two recent cases in which patients with abdomen-hand flaps kept their hands against their abdomens for four or five weeks under the suggestion that their hands were stuck to their abdomens and could not be moved, no matter how hard they tried. Only two strips of tape were used to help them, serving as quite a contrast to the plaster cast often employed.

A useful adjunct to this type of suggestion therapy is to have the patient write the doctor a note about his reaction to having an operation performed under hypnosis. The remarks are usually quite similar with phrases, of "wonderful sensation," "relaxed feeling," "no pain or discomfort," and "will recommend it to others and do it again." A seventy-six year old man with hypertensive cardiovascular disease and a history of a recent coronary occlusion, requiring excision of a large basal cell carcinoma from his back and repair with a split-thickness skin graft, wrote the following:

"Dear Doctor:

"While I first had reservations in my mind about hypnoanaesthesia for my operation, your explanation convinced me it was a logical thing to do.

"My experience this morning was very rewarding. It seemed to me such a short time that it was not possible to do the work. My mind was in a detached feeling from the operation, experiencing no discomfort during the operation, although I was aware of what was going on. The after effects left me in a normal condition, except for the annoyances of the bandages on my back.

"I cannot speak too highly of this method and your procedure in handling the operation.

"Cordially,
"R. W."

Whenever possible, as in elective procedures, we like to give the induction and conditioning to the patient prior to admission to the hospital. This takes from five to fifteen minutes and prepares the patient mentally for the hospitalization and surgery, as well as for postoperative care. This saves time in the schedule of a busy operating room, because in the operating room one effects a second stage induction which takes a few seconds and consists of giving the patient the signal to enter a hypnotic trance. Anesthesia is then suggested and supplemented with a local anesthetic. Surgery is performed, posthypnotic suggestions relative to healing are given and the patient is awakened. The whole procedure is performed without talking or giving explanations to the patient (as with the patient under local anesthesia alone), usually in much less time because of the reduced bleeding.

A disguised approach can be used in the emergency room, putting the patient into a hypnotic trance without mentioning hypnosis. This can be carried out in a few minutes with very little effort in a motivated patient.

Steffanoff stimulated my interest in hypnosis and assured me that one would find it a useful adjunct to one's practice. We have found it so, and wish to add that this type of positive thinking helps the doctor as well as the patient. It helps the patient develop extreme confidence in the doctor and his treatment. It gives the

doctor a relaxed patient prior to, during and after surgery, and puts him in complete control of the situation. I wish to emphasize that hypnosis is not a "cure-all." It is merely another tool to use in the treatment of patients. Perhaps this presentation will stimulate the study and use of hypnosis in maxillofacial practices.

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Mandibular Prognathism Corrected by Oblique Ostectomy of the Ramus*

A NEW, PRECISE, MECHANICALLY CONTROLLED TECHNIQUE

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SINCE the first operation by Hullihen in 1848 for the correction of a pseudoprognathism, many different operations for the correction of mandibular prognathism have been presented. The various types of operations based on anatomic location may be classified generally as follows: (1) ostectomy of the body of the mandible, (2) condylectomy, (3) osteotomy of the ramus, and (4) ostectomy or osteotomy of the angle. The fact that there have been so many different operations advocated indicates that a classic surgical procedure has not been evolved.

As a result of a long period of research and study, including a comprehensive review and evaluation of the literature, we have developed a new technique. We are convinced that this new technique has many advantages over those methods now in use. In evolving this technique we draw on an experience of forty years in this field which one of us (A. E. S.) has had, during which time a total of 147 prognathic patients have been operated upon, using the following methods: (1) ostectomy of the body, (2) horizontal osteotomy of the ramus, (3) submandibular notch ostectomy with sliding condylotomy, and (4) the new oblique ostectomy of the ramus which is being introduced in this paper. Fair results were obtained with the first two methods but they were abandoned because they did not conform to sound surgical principles. Good results were obtained with the third method but still the research and study were continued, culminating in the evolution of the fourth method. In developing this new technique we have reviewed and evaluated over 175 articles on the subject in both the foreign and domestic literature.

We wish to pay a personal tribute to the orthodontists, prosthodontists, and other specialists and scientists whose extended research in studying the growth and movements of the mandible has been most helpful to us in working out this surgical technique.

HISTORY OF THE CASE USED TO ILLUSTRATE THE TECHNIQUE

The patient, a forty year old registered nurse from Milwaukee, first became aware of her deformity at age twelve. She was unaware that her deformity could be corrected until age twenty-six, when a dentist in the Army enlightened her. Her chief complaints were: (1) abnormal appearance, (2) inability to masticate food properly, (3) gastritis of many years' duration (repeated radiographs had been made because of suspected gastric ulcers), (4) speech impediment and (5) periodic soreness of tongue. Her appearance and occlusion were characteristic of this deformity. (Figs. 9A and B.)

Preoperative Evaluation. In addition to photographs and radiographs, models made from impressions of the alveolar arches are mounted on a special articulator with a ball and socket feature which permits any desired positioning of the mandibular model. The amount of posterior displacement is determined by making marks on the models. (Figs. 1A and B.)

* A motion picture, in color, illustrating this new technique, was first presented at the 62nd Annual Meeting of the Southern California State Dental Association on May 5, 1959. The motion picture was also shown at the 13th Annual Meeting of the American Society of Maxillofacial Surgeons.

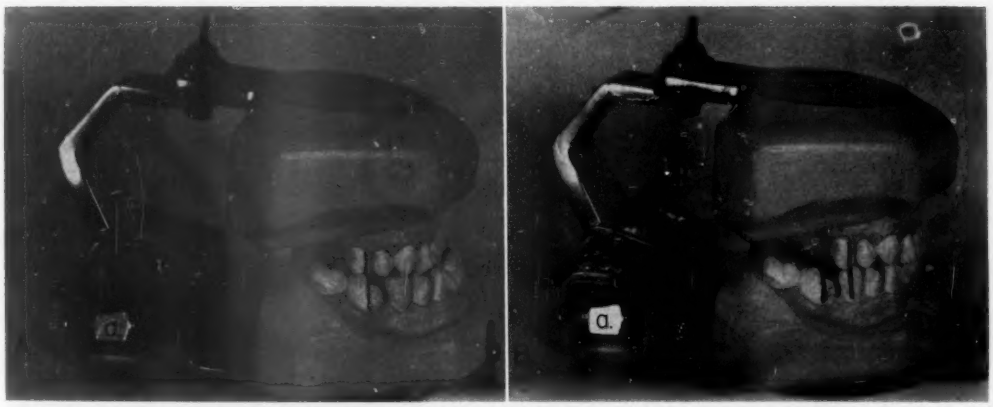

FIG. 1. Preoperative evaluation for our new technique. Study models mounted on metal articulator for determining the amount of posterior displacement required. A, preoperative prognathic relationship. B, the desired postoperative occlusion. The line on the maxillary tooth serves as a reference point. The two lines on the mandibular teeth represent the extent of the prognathic deformity. Note sliding bar with ball and socket joint (a) and amount of posterior displacement (b).

In the transposition of the anterior fragment of the mandible after oblique ostectomy in the ramus, there are usually two components of movement of the anterior portion of the ramus. There is customarily a vertical component as well as the more obvious horizontal displacement. This results from the curve of Spee as well as the individual variations of occlusion in each patient. Inasmuch as holes for receiving interosseous wires, which secure the bone fragments in proper apposition, are made before the sections of bone are removed, some provision must be made for accurately determining the relative position of the holes preoperatively.

In order to determine the proper placement of the holes the following method has been devised. A face bow measurement of the relationship of the maxillary arch to the temporomandibular joints is made on the patient. (Fig. 2.) This measurement is used to establish the same relationship between a maxillary stone model and a stone glenoid fossae bar. The stone bar is attached to a mounting board. A special metal adapter for receiving the face bow is attached to the bar. (Fig. 3A.) The proper relationship between the glenoid fossae bar and the maxillary model is established with the face bow, and the two are luted together with plaster of paris, forming a maxillotemporal unit. (Fig. 3B.) A stone mandible which conforms to the maxillotemporal measurement, as established by the face bow, is selected from our collection. The alveolar arch is removed from the stone mandible so that the patient's mandibular alveolar arch can be positioned in its place. The mandible, minus the alveolar arch, is adapted to the maxillotemporal unit with the heads of the condyles in the glenoid fossae. The dental arch of the patient's mandibular model is then adapted to the maxillary arch in the prognathic relationship by means of a wax bite pattern. (Fig. 3C.) The mandibular alveolar arch is luted to the stone mandible with plaster of paris. This stone articulator duplicates the essential relationships needed for making the preoperative study.

FIG. 2. Face bow registration is made on the patient, measuring the relationship of the maxillary arch to the temporomandibular joints.

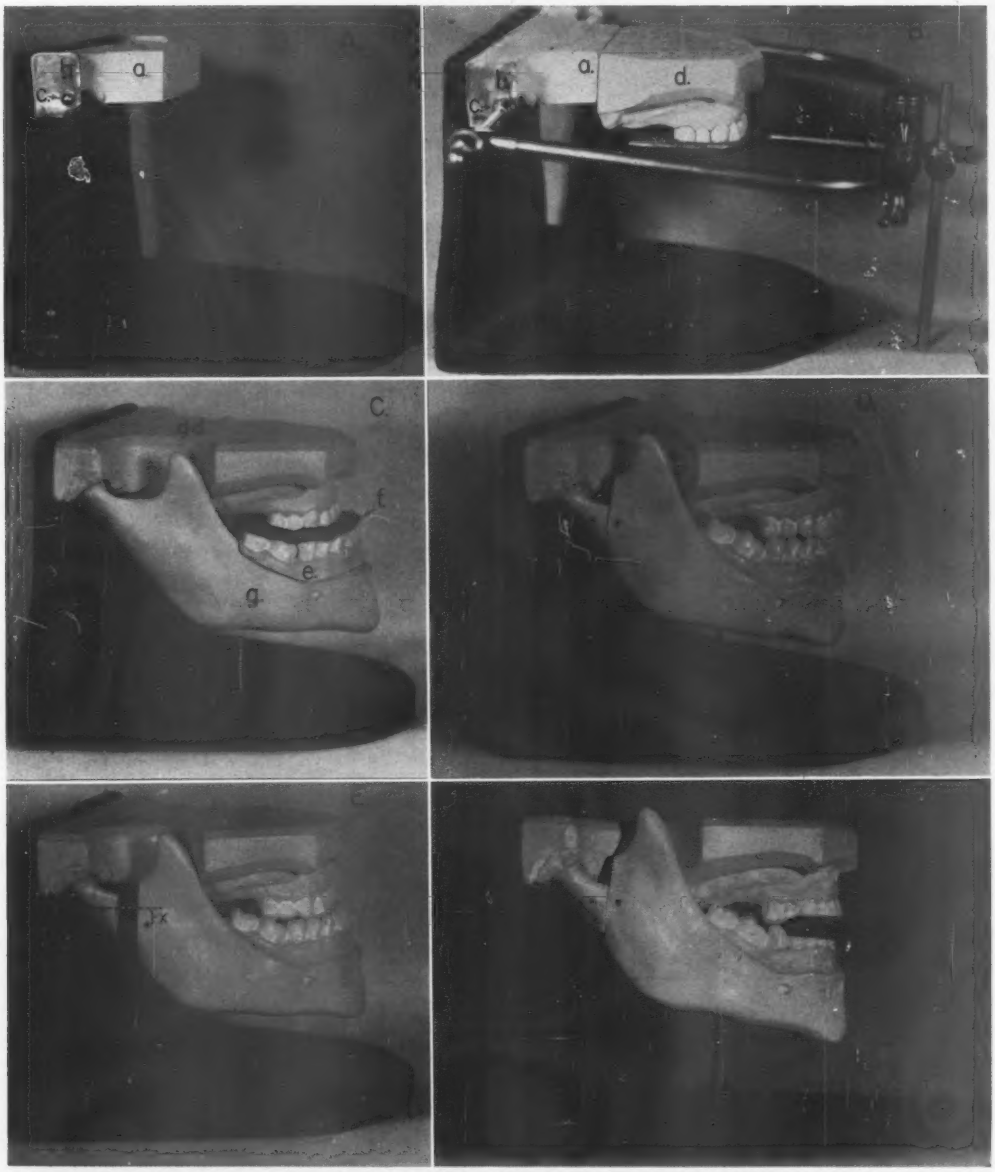

FIG. 3. Special stone articulator used in preoperative evaluation for our new technique. A, basic components for beginning construction. (a) Glenoid fossae bar. (b) Face bow adapter. (c) Condylar knob. B, maxillotemporal unit. Face bow is attached to condylar knobs (c) of adapter (b), and maxillary model (d) is luted to glenoid fossae bar (a) duplicating the face bow measurement made on the patient (see Fig. 2). C, stone articulator assembled. Patient's mandibular arch (e) is adapted to the maxillotemporal unit (a, d) in the preoperative prognathic relationship by means of a wax bite pattern (f). A stone mandible (g) is placed into position and luted to the mandibular arch. D, sections have been removed from the subcondylar region, simulating operation (see E), and the mandible is transposed. Two pencil dots are made perpendicular to the line of section representing the holes for interosseous wire which will be placed at the time of surgery. E, mandible returned to prognathic position. A line has been drawn through the posterior dot at right angles to the line of section. The shortest distance (x) from the line to the anterior

The condyles are then sealed in the glenoid fossae of the maxillotemporal unit with sticky wax. This is done so the condyles cannot move from their original position. The required width of stone, as determined on the metal articulator, is removed from the subcondylar region on each side with a plaster saw simulating the operation. (Fig. 3E.) The width of stone removed is equal to the posterior displacement necessary to establish the normal intermaxillary relation and improved occlusion. The desired occlusion is then established on the stone articulator and two pencil dots, representing the positions of the holes for the interosseous wires, are made. (Fig. 3D.) The prognathic condition is re-established and the dots then bear the relationship that is to be duplicated at the time of operation. (Fig. 3E.) A straight edge ruler is placed through the center of the posterior dot perpendicular to the line of section, and the shortest distance between the ruler and the anterior dot is measured. This measurement is used at the time of surgery to determine the position of the anterior hole. (Fig. 8A.)

Surgical Procedure. The patient is hospitalized, prepared and draped in a sterile manner. The field of operation is anesthetized with a local anesthetic. The mandibular division of the fifth cranial nerve is blocked at the foramen ovale with 3 cc. of a 2 per cent procaine solution containing epinephrine 1 : 100,000. The injection is made from a lateral approach through the space between the zygomatic arch and the mandibular notch [*1*] (Fig. 4.) The skin along the line of incision is infiltrated with procaine solution.

The proposed skin incision is outlined with a dermagraphic pencil. The line extends from a point approximately 0.5 cm. posterior to the lobule of the ear and follows the posterior and inferior contour of the mandible at a distance of approximately 1.0 cm. from it, to a point 2.0 cm. anterior to the gonial angle.

The incision is made through the skin along the previously marked line. By a combination of sharp and blunt dissection, the subcutaneous tissue, external cervical fascia and posterior border of the platysma muscle are divided exposing the gonial angle of the mandible. It is unnecessary to divide the external maxillary

FIG. 4. Third division of fifth cranial nerve is blocked at the foramen ovale through mandibular notch.

artery and anterior facial vein. The tendinous attachments of the masseter muscle and overlying tissues are elevated and retracted superiolaterally with a special concaved retractor, exposing the lateral aspect of the ramus superiorly to include the mandibular notch.

A curved periosteal elevator is used to separate the periosteum from the central portion of the posterior border of the ramus. The elevator is then advanced, separating the soft tissue from the medial surface of the ramus from the posterior border to the mandibular notch. Care is taken to keep the elevator posterior to the mandibular foramen and in contact with the bone. In this manner the internal maxillary artery and inferior alveolar artery and nerve are displaced medially. The elevator is withdrawn and a newly devised self-retaining metal retractor, designed to fit the general contour of the medial surface of the ramus, is inserted in its place. (Fig. 5.) The retractor is approximately 1.5 cm. wide and, when in place, extends from the posterior border of the mandible at the level of the lobule of the ear to the mandibular notch. The presence of this instrument serves to protect the underlying structures during the subsequent cutting of bone. (Fig. 6.) Two special retractors are used, one for each side. (Fig. 5.) The retractors have a curved portion that projects approximately 0.3 cm. laterally through the mandibular notch. This curved end contains a small rectangular slot. A cutting guide made

dot is measured. This measurement represents the vertical component of movement of the ramus, and is the primary reason for the construction of this articulator. F, plastic bite key (h) made on anterior teeth in corrected relationship to be used on patient for rigid stabilization. Note position of pencil dots and elevation of ramus as in (D).

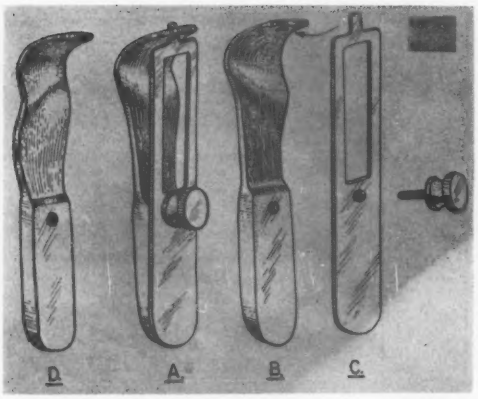

FIG. 5. Self-retaining appliances used to insure accuracy and safety in the removal of bone. A, assembled unit for right side. B and C, unit disassembled. B and D, self-retaining retractors for right and left side, respectively. C, cutting guide and locking screw.

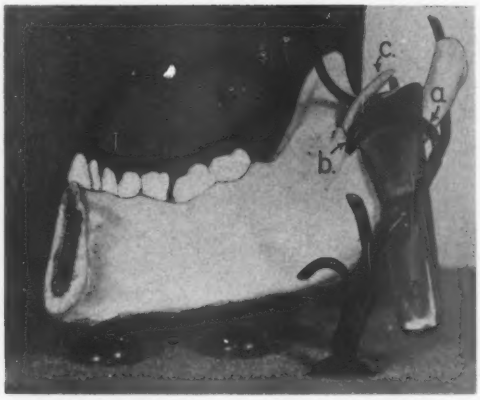

FIG. 6. Handmade model illustrating position of special retractor (A) on medial surface of mandible. Note how retractor shields internal maxillary artery (a), and inferior alveolar artery (b) and nerve (c), and other structures medial to the area of resection.

of a flat piece of resilient stainless steel with a pointed end is slipped into the slot of the retractor and clamped firmly at the opposite, posterioinferiorly placed end by means of a screw. (Fig. 5.) That portion of the ramus between the two pieces of the unit is thereby bound securely. The cutting guide has a window which corresponds in width and configuration to the section of bone to be removed. (Fig. 5.) The cutting guides are made to fit the individual case as determined on the stone articulator. (Fig. 3E.) The same cutting guide may be used on both sides in an equilateral case of prognathism. However, in such cases as laterognathism different sized cutting guides must be used to establish midline occlusion.

Before the sections are made for removal of bone, a hole is made on each side of the cutting guide to be used for insertion of an interosseous wire for holding the fragments in proper rigid position following ostectomy. These holes are made using a special self-cleansing surgical bur. (Fig. 7.) The first hole is drilled in the central portion of the neck of the condyle adjacent to the cutting guide. (Fig. 8A.) The second hole is drilled in the ramus immediately anterior to the cutting guide with special attention to its relative position to the first or posterior hole. (Fig. 8A.) The method of determining the position of the second hole, which is a critical factor, has already been discussed. (Fig. 3E.)

Two sections are then made in the bone by cutting along each side of the cutting guide, using a special flat-ended bone bur irrigated with normal saline solution. (Figs. 7 and 8B.) After the piece of bone extending from the mandibular notch to the posterior border of the mandible has been removed, the anterior and posterior fragments are still held securely in

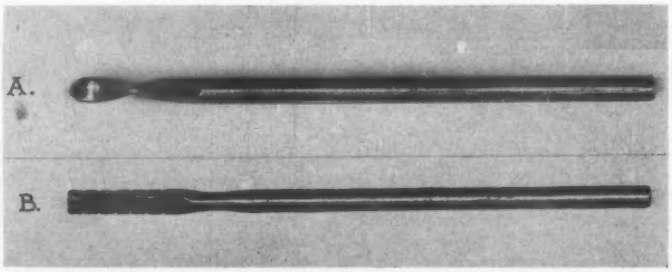

FIG. 7. Special bone drills. A, specially made, rapid-cutting, self-cleansing auger drill. B, special flat-ended, side-cutting bone drill.

FIG. 8. Our new surgical technique demonstrated on patient's photograph. A, appliance locked in position and holes for interosseous wire drilled in the relationship to each other as predetermined on the stone articulator (see Fig. 3E). B, accurate section of bone removed through window of cutting guide. Appliance holds fragments in rigid position during cutting operation. C, mandible has been transposed to establish normal intermaxillary relation and improved occlusion. Note accurate approximation of bone fragments and rigid immobilization by non-electrolytic wire. Holes are now at right angles to line of section with the ramus elevated.

their original position by the appliance. (Fig. 8B.)

The screw is removed from the appliance, releasing the cutting guide which is also removed. A No. 24 gauge non-electrolytic wire is placed through the holes. The retractor is then removed. The cut surfaces of the bone are accurately approximated, as the mandible is transposed on the side of operation. The wire is twisted to maintain close approximation and rigid immobilization of the fragments. (Fig. 8C.) In this manner the condylar head is retained in the glenoid fossa in its original position.

The wound is closed by approximating the deeper layers of tissue with No. 2-0 plain catgut sutures. The skin incision is closed with subcuticular No. 32 gauge non-electrolytic wire and interrupted No. 3-0 nylon sutures.

The wound is covered with gauze, the patient's head turned to expose the opposite side, and a similar procedure performed upon the contralateral side of the mandible.

Upon termination of the procedure on the

FIG. 9. Preoperative and postoperative appearance of patient. A, preoperative profile of prognathic patient used in illustrating our new technique of oblique ostectomy of the ramus. B, preoperative class III malocclusion. C, postoperative appearance. The technical operative procedures described herein have produced a normal profile. Note minimal scarring. D, note normal intermaxillary relation and improved occlusion.

second side, the plastic bite key, which has previously been made on the stone models in the corrected position (Fig. 3F), is placed between the anterior teeth. In dentulous patients the mandible is immobilized by intermaxillary elastic traction on arch bars. In edentulous patients a special intraoral splint is used and the mandible is immobilized by means of a head cap, chin cup and connecting straps. A head bandage is then applied with moderate pressure.

The head bandage and skin sutures are removed on the fourth postoperative day. The subcuticular wires are removed on the eighth postoperative day, and the mandible is mobilized approximately four to six weeks postoperatively, the exact time depending upon radiographic findings. Experience may indicate that the mandible can be mobilized earlier. In

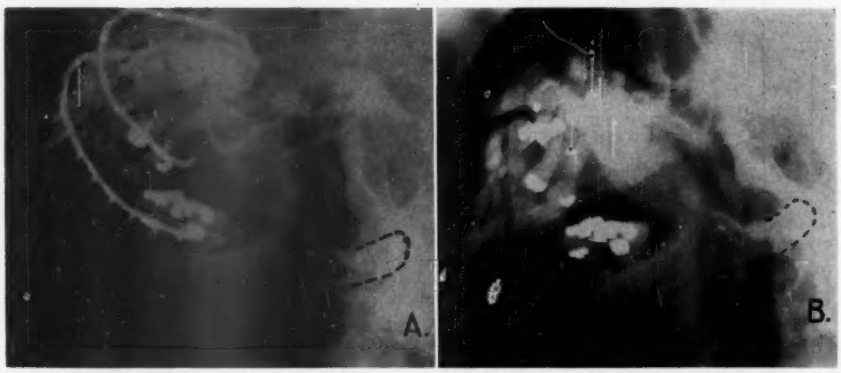

FIG. 10. Postoperative radiographs showing union of bone fragments. A, radiograph made six weeks following surgery. Note good union of bone and presence of non-electrolytic wire loop. B, radiograph made eleven months following surgery. Note complete union of bone fragments.

one patient who was edentulous, except for the presence of the four mandibular incisors, all methods of immobilization were discontinued on the twelfth postoperative day. The mandible healed normally, without alteration of position and without complications.

Results. After bilateral correction, this new technique has produced: (1) a balanced profile (Fig. 9C); (2) normal intermaxillary relation (Fig. 9D); (3) improved occlusion (Fig. 9D); (4) improved muscular balance; (5) improved speech; (6) improved mastication and resolution of gastritis; and (7) improved psychological status.

These features have been accomplished: (1) without loss of teeth; (2) without excision of bone from the body of the mandible which would have shortened the floor of the mouth and reduced the space for the enlarged tongue; (3) without widening the lower third of the face; (4) without interfering with the inferior alveolar nerves, arteries or veins; (5) without paresthesia of the chin or lower lip; (6) without noticeable scarring; (7) without overlapping bone fragments of the ramus; (8) without producing a deformity of the temporomandibular joints by altering the position of the condylar heads; (9) without creating an open bite deformity, or (10) without prolonged immobilization of the mandible, which is necessary when accurate approximation of the fragments is not obtained.

There was radiographic evidence of good bony healing six weeks following surgery. (Fig. 10A.) The permanency of the surgical results was demonstrated by a radiograph made eleven months postoperatively. (Fig. 10B.)

SUMMARY

The importance of the growth of the ramus in normal development of the mandible has been recognized for many years. Sarnat [2] has shown the importance of condylar growth experimentally in monkeys. Ricketts [3] has demonstrated the importance of condylar growth in children using a special radiographic technique. No one has proved that prognathic mandibles develop by any mechanism or in a manner greatly different from that of normal mandibles. The prognathic mandible seems to be an expression of quantitative growth rather than of qualitative growth. The size and shape of the alveolar arches of prognathic patients are usually harmonious after their relationship has been corrected. Therefore, the configuration of the prognathic mandible seems to verify the fact that the overgrowth of bone occurs mainly in the ramus, perhaps greatly influenced by condylar growth, as in normal development.

For these reasons we believe an operation in the subcondylar region, as close to the origin of overgrowth as possible, properly performed, will produce the best anatomic and physiologic results. Some of the operations used in the treatment of prognathism, such as those involving the overlapping of bone fragments, produce a second deformity while attempting to correct the original deformity. In the application of our technique we have followed sound orthopedic surgical principles in order to correct the prognathism, while producing a

minimal disturbance of the normal anatomic position of the associated structures, thereby maintaining or enhancing proper function and improving esthetics.

The submandibular approach, or modification thereof, has proved to be a very popular method of entree into the ramus. With proper precautions the two possible complications which have been mentioned in connection with this approach, i.e., injury to the mandibular branch of the facial nerve and parotid fistula, have not proved to be troublesome in a variety of maxillofacial procedures in which this approach has been used.

The ever-present possibility of injury to the internal maxillary artery, and the inferior alveolar artery and nerve which exists in operations on the superior portion of the ramus has been eliminated by the presence of the protecting retractor. (Fig. 6.) At the same time accuracy is assured by the use of a precise cutting guide.

By careful preoperative study on a stone articulator, as described herein, the relationship of the holes for interosseous wiring can be determined so as to allow for vertical as well as horizontal transposition of the anterior segment which bears the dental arch, and a balanced occlusion with a positively controlled edge-to-edge approximation of the bone fragments can be assured.

We believe this new technique of oblique ostectomy of the ramus offers the following advantages:

1. The operative area, as far as we can determine, is as near the anatomic origin of the deformity as possible.

2. The subauriculomandibular approach offers adequate exposure for good visualization of, and access to, the operative area and leaves an inconspicuous scar.

3. There is no oral contamination of the wounds and an aseptic surgical technique is possible.

4. The special self-retaining retractor offers maximum protection to important blood vessels and nerves medial to the site of ostectomy.

5. The preoperative study and precise cutting guide assures accuracy of ostectomy.

6. At the site of operation the ramus is devoid of important blood vessels and nerves, and is relatively free of muscle attachments.

7. The intact body of the mandible and its contiguous tissues are transposed as a unit.

8. The edge-to-edge approximation of bone fragments, stabilized by interosseous wires, reduces the period of immobilization to a minimum and prevents an open bite deformity.

9. The muscles of mastication, with the exception of the external pterygoid muscles, remain attached to the large, denture-bearing, anterior fragment of the mandible which further tends to stabilize the mandible and prevent an open bite deformity.

10. There is minimal disturbance to or enhancement of the functional positions of the muscles of mastication, muscles of the floor of the mouth and the tongue.

11. No teeth are sacrificed or devitalized, and the size of the alveolar arch is not diminished.

12. The acuteness of the gonial angle is increased.

13. The heads of the condyles are retained in their original positions, thereby maintaining the integrity of the intratemporomandibular joint anatomic relationships.

14. By the removal of accurate sections of bone and interosseous wiring, proper alignment of the fragments is maintained.

15. There is no danger of interposing soft tissue between the bone fragments, and healing of bone in the subcondylar region is excellent.

16. The technique requires no elaborate or special method of intermaxillary fixation during the healing process, and is an excellent procedure for edentulous patients.

Acknowledgment: We wish to acknowledge the efficient service and cooperation of Mr. Zolton Yuhasz, artist and medical illustrator, Doheny Eye Foundation, St. Vincent's Hospital, for his help on some of the illustrations.

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A New Treatment of Ameloblastomas

PRELIMINARY REPORT

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THE ameloblastoma is a benign, radioresistant neoplasm of odontogenic origin. The clinical and roentgenographic features and histopathology of the tumor are well known [*13*]. Management remains a moot question, however, primarily because the tumor through systemic spread has never been reported in the literature and when metastasis is present in the lung, it may be explained by inhalation of fragments of the tumor into the bronchial tree, in other words, implantation of tumor cells in the tissues.

Total enucleation can result in complete cure. However, the architectural pattern of the tumor is such that complete removal is seldom, if ever, achieved by enucleation. Block or radical resection, therefore, has become the most widely used form of therapy. Even after radical resection, however, there is recurrence in 13 per cent of the cases [*11*], and recurrence may occur even twenty-five years after the original surgery [*12*].

This article illustrates the problems encountered in the clinical management of recurrent ameloblastoma and reports preliminary findings on a new method of treatment of the aforementioned neoplasm.

CASE REPORT

J. H., a fifty year old white man, had been in excellent health except for many episodes of recurrent masses in the right mandible and facial bones. His dental history dated back over a twenty-two-year period; during this interval he has had "multiple" surgical procedures [*10*].

In 1937 the right mandibular third molar was extracted due to dental pain. No preoperative dental roentgenograms were taken. Healing was prolonged. A slow growing swelling developed in the same area and in 1947, with the patient under local anesthesia, a "bone cyst" was removed. This was a "local" excision of the lesion intraorally. The tumor was diagnosed as "adamantinoma of the mandible."

In 1948, six months later, the patient presented with a solitary, solid tumor mass involving the right ascending ramus and body of the mandible, anterior to the right first molar area. The patient was admitted to the hospital for a "radical" or "block" resection, and right hemimandibulectomy was performed.

The patient was seen periodically and was quite well until 1954. In August 1954 he returned with a mass in the right temporal region. The radiographic examination was essentially normal and the mass was removed *in toto* with the patient under local anesthesia. It was encapsulated and embedded in the temporal muscle. The pathologic diagnosis was "ameloblastoma" involving the temporal region.

The patient was followed up and was seen again in August 1956, when he presented with protrusion of the right malar region. Examination showed that the mass was hard, firm, non-tender and sessile. The skin was stretched, shiny and intact. Affection of buccal branches of the seventh nerve was observed, as indicated by drooping of the right upper lip and cheek. The eye was not displaced, and there were no subjective ocular symptoms. Roentgenographic findings revealed progression of tumor, destroying portions of the right zygoma (including the orbital process and the lateral aspect of the orbital rim), as well as the lateral bony wall of the right antrum.

Surgical exploration showed a tumor which had invaded deeply into the tissue spaces and had caused extensive destruction of the right zygoma, lateral wall of the orbit and the maxilla. Since the patient had not consented to radical resection, the

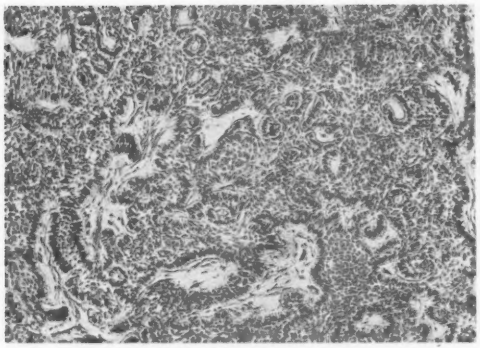

FIG. 1. Photomicrograph showing typical appearance of ameloblastoma.

tumor mass was only partially removed. The postoperative course was uneventful.

Microscopically, the section revealed cords and nests of simple columnar epithelium lining cyst-like spaces. These showed variations in size. Some were empty; others were filled with an amorphous, fibrillar, eosinophilic substance. The columnar cells were supported by a loose tissue whose cellular components resembled the stellate reticulum of the enamel organ. (Fig. 1.)

The diagnosis was ameloblastoma, incompletely removed.

The patient now presents an inoperable condition and in December 1958, returned with progressive swelling in the right zygomatic facial region. (Figs. 2.) The subjective symptoms were occasional episodes of "dull ache" with throbbing and pressure. He had deafness in the right ear and distortion of the right eyeball and vision.

There were two major problems with which we were now confronted: (1) the mode of therapy and (2) the repeated episodes of recurrence of the tumor.

Recently Dalitsch [4] has reported and reintroduced the concept of induced regression of neoplasms by the controlled limitation of vascular supply. His views are authenticated by many well known workers, namely, Everson and Cole [5], Lewis and Aptekman [6] and Birch [1].

Cole [2,3] and his associates have clearly pointed out the mechanism of spread of the neoplasm and have categorized it in four major groups. They may be summarized as follows: (1) by lymphatics, (2) by vascular channels, (3) by contiguity through tissue planes, and (4) by implantation. The mechanism of spread of the neoplasm by which the ameloblastoma spreads includes the latter two groups.

At this time we wondered if we could use

FIG. 2. Lateral and front views of the patient showing recurrent ameloblastoma involving the maxillofacial structures during the past twenty-two years. He has had "multiple" surgical procedures (December 1958).

sclerosing solutions not only to produce ischemia in the entire area including the tumor but also to produce fibrogenesis around the tumor, thereby controlling the mechanism of spread of the neoplasm.

In 1936 Rice [7] reported that he treated over 600 hernias with a sclerosing agent, sodium psylliate, which gave him encouraging results without producing ill effects. He concluded that this solution furnished the best method of developing fibrogenesis in the treatment of hernia.

In view of Rice's results, Schultz and Shriner [8] decided to test various sclerosing agents on a variety of animals. In brief, the animal experiments showed: (1) Sodium psylliate is the best of the fibrosing agents investigated. (2) It is non-injurious to tissues generally. (3) Injection into the heart produced no recognizable effects. (4) No infection followed the treatment. (5) It produces no apparent, systemic disturbances even when injected intravenously into animals. (6) Fibrosis of the tissue begins in four to six days.

Clinical Application. The harmlessness of treatment with sodium psylliate and the quick results obtained convinced one of us (L. W. S.) that it was the agent of choice for subluxation of the temporomandibular joint. Thus the senior author was the first to advance the idea twenty-two years ago, and since then has been injecting Intracaine® or Sylnasol® into the joints for hypermobility of temporomandibular joint disorders. No untoward postinjection sequelae have been encountered and the aforementioned sclerosing agents are believed to be quite safe.

Sclerosing agents have also been injected into hemangiomas to produce fibroblastic proliferation and sclerosis. The clinical results have been favorable.

With the previously mentioned experimental and clinical evidence, we decided to begin a clinical trial and inject sclerosing agents into this inoperable recurrent case of ameloblastoma. The patient was told the nature of the treatment and we obtained his consent to institute therapy.

Nature of Therapy. First, using a hypodermic syringe with a 20 gauge needle, we injected 5 cc. of Sylnasol around the tumor mass to determine tissue reaction and the patient's response. The patient tolerated the injection. The skin and surrounding tissue showed no untoward reactions. The larger dose of 15 cc. of Sylnasol was then injected deep into the tumor mass and surrounding tissues. The injection technic consisted of infiltrating the entire area with the idea of limiting blood supply by causing fibrogenesis.

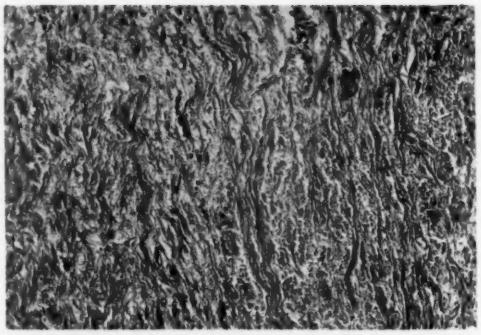

FIG. 3. The sclerosing agent Sylnasol was injected into the tumor mass. After eight weeks a biopsy specimen was taken, the microscopic findings showing dense fibrous connective tissue with some fragmentation of collagen fibers and chronic inflammation. No evidence of ameloblastic cells was noted in the biopsy material.

The injections were repeated every two weeks. After eight weeks a biopsy specimen was taken to study the tissue reaction and changes in the tumor mass. The following pathologic findings were interesting and very fascinating.

Microscopically, sections showed a triangular tissue mass, of which one surface was covered by a stratified epithelium. The covering epithelium was about 8 cells thick with short, blunt, rete pegs. While the surface cells of the epithelium were filled with basophilic granules, the basal cells were encroached upon with golden brown pigment. The immediate underlying connective tissue from the epithelium was loose and composed of fibroblasts and lymphocytes scattered in a matrix containing bizarre, fragmented collagenous fibers. The bulk of the remaining tissue was composed of dense collageneous fibers, arranged in a fibrillated and longitudinal fashion. Perivascular infiltration by lymphocytes was observed in some areas. Thin layers of adipose tissue were also seen. There was no evidence of an ameloblastoma. (Fig. 3.)

The diagnosis was dense fibrous connective tissue with some fragmentation of collagen fibers; chronic inflammation; no evidence of ameloblastic cells noted in biopsy material.

FIG. 4. Clinical appearance of the patient (April 1959) shows marked "regression" of the tumor mass. He had received eight injection treatments; each dose was 10 to 15 cc. injected over a twelve-month period.

The biopsy report encouraged and stimulated our efforts and trial. The injections were repeated at two-week intervals. Twelve weeks later we found chemical liquefaction of the tumor mass, and multiple aspiration of tumor exudate revealed cellular debris. Several weeks later multiple fistulas were noted, and marked regression in size was evident. Large representative biopsy specimens were taken from several areas of the tumor at the end of six months. The pathologic findings were consistent with dense fibrous connective tissue. No ameloblastic cells were noted.

The patient was examined repeatedly. The multiple sinuses closed spontaneously after several weeks (April 1958). The patient remarked "he is feeling better than he has been for many months."

The injections were discontinued and marked regression of the tumor mass has been noted. (Fig. 4.) In summarizing, the patient had received eight injection treatments, the dose was 10 to 15 cc. over a twelve-month period.

Clinical Observation and Suggestions. Injection of the sclerosing agent Sylnasol into the ameloblastoma showed (1) complete fibrosis around the tumor mass, (2) no evidence of ameloblastoma of the tissue noted in the tumor, (3) marked regression in size and (4) no evidence of spread of the neoplasm.

We suggest that injection of Sylnasol may be made every other week. The dose is 10 to 15 cc. and six to ten injections are needed to treat a neoplasm, depending on the size of tumor.

At the present time we are only able to institute this therapy in tumors which are accessible to local injections.

COMMENTS

Our clinical observation reveals that the injection of sclerosing agents into the ameloblastoma has opened up many avenues in the treatment of benign and malignant neoplasms. By injecting sclerosing agents into the neoplasm we may note (1) proliferation of fibrous cells, (2) disappearance of neoplastic cells, (3) regression of neoplasm and (4) possible blocking of the local or systemic spread of neoplastic cells. Thus this may facilitate surgical procedures and prevent systemic metastasis.

We therefore suggest that this interesting effect should be studied on a larger series of patients over an extended period of time, for

not many patients have been treated by this method nor has there been a sufficient time lapse to draw positive conclusions. This is a preliminary report and our clinical claim is supported by three cases of ameloblastomas. Further research in the clinical application is under way.

It is our earnest hope that these agents be given an experimental and clinical trial so that some day we might control one of the killers of the human race—cancer.

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Surgical Management of Intraoral Cancer

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MANY of the superficial and accessible intraoral carcinomas appear to be readily and adequately excised by surgical means. Yet, the very fact of their superficial location has been in part the cause of a reluctance to employ surgical means when facial structures or structures of articulation are involved. A reluctance to alter communication or to create feeding problems surgically has been an influencing factor, and thoughts of cosmetic results have sometimes fogged consideration of the patient's survival when dealing with malignant tumors of the oral cavity.

A reluctance to employ surgical means was understandable in the past when we recall the problems of anesthesia, fluid balance and nutrition, and the poor control of infection prior to the availability of antibiotics and chemotherapy which we now take for granted. This reluctance led to the avoidance of surgery and a dependence upon radiation therapy to such an extent that prior to the past decade the management of intraoral cancer was widely held to be solely radiologic.

While the responsibility for care of patients with malignant tumors resulted in sincere efforts and development of special radiologic methods, radiation therapy was not ideal. Intraoral cones were combined with external exposures of mobile internal structures. The insertion of radium needles was often actually a surgical procedure. Implants and molds require judgment of distance and depth of invasion and evaluation of a margin of safety no less exacting than cutting or electrosurgical means, and the resulting slough has differed only in time of occurrence and lack of immediate control from surgical excision or electrocautery. However, it must be said that there were some successful results. The newer betatron and cyclotron means of radiation have not been widely available, and their value in oral cancer cannot yet be widely determined. Regardless of the source of radiation employed, the immediate response of the tissue is inflammatory. This is accompanied by pain and swelling of such degree as to create problems of feeding and speech no less severe and usually more prolonged than those experienced following surgical methods. It is not surprising that when improved surgical adjuvants made a reappraisal possible, surgical intervention rapidly gained favor with many of us dealing in the problems of carcinoma of the mouth. Previously presented results [1] tend to support the surgical approach and it is hoped that they will further stimulate its wider use. In our experience, surgery offers the patient an improved outlook with less discomfort and without a significant loss in function or extensive change in outward appearance.

"Adequate" surgery in dealing with carcinoma of the oral cavity may call for localized or extensive removal of tissue, and the concept of adequate surgery is more to the point than that of "radical" surgery [2]. From the standpoint of classification, it would be desirable to be able to describe specific surgical procedures for the various lesions that are encountered. However, each operative procedure must be planned on the needs of the individual patient since the exact site and extent of each tumor may alter the choice of the surgical attack to be undertaken. The guiding surgical principle does not vary from that employed in dealing with most malignant tumors: total eradication of the pathologic process in the first attack. We must be guided by the thought that we are dealing with a disease that uncontrolled will ultimately and surely kill the patient. In the areas of the head and neck the fatal outcome will usually be preceded by a loss of organ function and by visible deformity, so that the initial attack must be total, not a temporizing

or obscuring maneuver that has been compromised before it is started. Excision is complete, and when the path of lymphatic metastasis can be predicted and anticipated, the area of potential spread is included as part of a block excision.

There are limitations to surgery of tumors of the oral cavity; in such circumstances clinical results dictate the use of radiation therapy for the primary tumor with delayed surgical management of operable cervical adenopathy when it subsequently develops after control of the primary site. This form of procedure is applied in four situations: (1) Lesions of the base of the tongue with extension into the body. Carcinoma of the base of the tongue proper invariably has invaded the epiglottis and preepiglottic regions, and only total laryngectomy coupled with resection of the base of the tongue will permit adequate excision. (2) Tumors that have caused fixation of the tongue. When the tongue is fixed by invasion to its body the spread has usually extended to the opposite side. Surgical eradication of the disease without irreparable physiologic damage is usually impossible, and in general we consider a lesion that causes some fixation of the tongue as inoperable. (3) Lesions of the lateral border of the tongue with extension to the adjacent anterior pillar and the tonsil. (4) Extensive lesions of the anterior pillar, tonsil and soft palate. Necessary surgery for extensive lesions in the latter two sites distorts the return to satisfactory physiologic status out of proportion to immediate and late tumor survival rates.

In a few regions of the oral cavity, management of localized malignancies is adequately and satisfactorily dealt with by local excision by cold knife or electrosurgical means. The employment of electrosurgery, when indicated, has been a constant source of encouragement; it offers technical simplicity, and its adequacy is impressive when compared with radiation methods for comparable tumors. Likewise, the minimal morbidity and excellent healing without physiologic interferences are also in its favor. Electrosurgical removal of small localized superficial malignancies is employed in: (1) The floor of the mouth, without extension to the tongue or mandible, (2) the hard palate, (3) the buccal mucosa, and (4) the small lesions located on the anterior pillar or soft palate.

These areas have in common the fact that they would not permit primary closure with good healing and return of function after incisional surgery. An early return of function following the healing by secondary intention that follows electrosurgery is the usual course.

At the other extreme are the patients whose tumors appear to be on the borderline of operable feasibility with an adequate margin of safety. One cannot always judge the possibility of surgical eradication solely on clinical examination, and the true limits of the extent of the tumor may be apparent only at the time of surgery. It is these patients that are known as poor tumor risks and are likely to present residual disease at a fairly early postoperative date. Nonetheless, we believe they deserve surgical evaluation as long as there is a reasonable chance of a favorable outcome.

There is also a problem, somewhat singular, encountered in a relatively high incidence in the mouth. That is the problem of "area carcinoma." This problem is characterized by apparent multiple primary lesions within the region, either observed concurrently or as a series of primary lesions in non-continuous and non-contiguous locations. At present no method of treatment appears to offer adequacy in the over-all picture.

In this presentation I am chiefly concerned with those clinical states of oral malignancies in which surgical treatment has been gaining increasing favor with an ever increasing number of interested surgeons. Predominantly, adequate local surgical excision of carcinoma of the mouth is limited to the tumors of the anterior two-thirds of the tongue. Patients with these relatively early cases respond well to adequate resection with primary closure. Rarely are cervical metastases present and dissection of the neck is not carried out electively because of the high incidence of contralateral metastases. The localized resections may vary from an area a few centimeters in extent to hemiglossectomy. The operator must be certain of the feasibility of closure of the wound without impairment of function. Routinely, the presence of unilateral metastatic nodes necessitates a complete dissection of the neck at the time of removal of the primary tumor. In early tumors of the tongue, the cervical metastases are, on the basis of experience, a second malignant site without direct continuity with the primary tumor when the floor is not involved. The spread from the primary site to the secondary lymphatic bed has been of an embolic nature, and subsequent

retrograde permeation of the lymphatic pathways has not been the rule. With this reasoning a "pull-through" procedure is not advocated to create a block, bu. rather the fields should be considered as two separate neoplastic sites that require resection of each. The "pull-through" procedure in our hands was associated with difficulties in closure and with poor primary healing. Should the closure of partial glossectomy compromise function, hemimandibulectomy is made a part of the procedure.

A notable forward step in the management of oral carcinoma has been chiefly the surgical attack on those tumors in which adequate excision has been associated with hemimandibulectomy and dissection of the neck. As stated previously, when excision in hemiglossectomy precludes primary closure, hemimandibulectomy should be performed. In addition to this indication, unilateral lesions of the tongue that extend to the floor of the mouth and lie adjacent to the mandible or extend to the mandible, with or without clinical evidence of cervical metastases and with or without evidence of bony involvement require a block excision of tumor, hemimandible and complete dissection of the neck in continuity. The feasibility of extending this composite resection to include lesions which also involve the anterior pillar depends upon individual skill and judgment.

Similarly, the extensive lesions of the floor of the mouth or of the alveolar process with extension to the lingual or buccal gutters are also treated by composite resection including hemimandibulectomy and dissection of the neck. There are superficial carcinomas of the alveolar process, upper or lower, that may be encountered sufficiently early to permit adequacy in management by wide excision coupled with alveolectomy.

Extensive palatal lesions do not pose specific problems. When small, as mentioned previously, destructive and excisional electrosurgery is adequate to eliminate the disease. When more extensive and when there is clinical evidence of invasion of bone, some form of maxillary resection will generally circumvent the tumor.

Guided by these generalities and adapting them to specific patients, what is the outcome? The first benefit of the surgical approach is that of the patient's comfort. The discomfort associated with radiation therapy for carcinoma of the mouth is only appreciated by day to day follow-up of the patient. The patient undergoing surgical attack has very little immediate postoperative discomfort and no late pain. The return to normal function is equally rapid.

It is concluded that, while radiation is still a serviceable and effective modality, surgical excision of intraoral cancer at present appears to offer more for the patient than do other methods of treatment. It offers equivalent or better survival rates; it is more likely to offer greater immediate comfort to the patient; and it is not a more deforming procedure than full-course radiation with its immediate and late effects.

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Therapy in Cancer of the Head and Neck with the Betatron Electron Beam

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THE betatron is capable of producing two beams, one a beam of high energy x-rays, the other a beam of high energy electrons. The high energy x-ray beam has little advantage in clinical application over the so-called supervoltage x-rays of 2 to 8 million volts. It is therefore the electron beam that is of present interest to us.

The first patient ever to be treated with the electron beam was treated at the University of Illinois in March 1951. Between then and the end of 1958, eighty-six patients had been treated. At first, chief interest had been in the x-ray beam. Because of this and the decision to limit the number of patients treated with the electron beam until some evidence with respect to long term effects should accumulate, few patients were treated until quite recently. Primary interest has now shifted to the electron beam, and with gains in experience and confidence in the results, restrictions on the choice of patients have been gradually lifted. Adequate material for evaluation of survival should be available in a few years.

Most of the patients treated to date have suffered from malignancies of the head and neck. The reason for this selection is twofold. First, the region of the head and neck is anatomically favorable for the physical characteristics of the electron beam. Second, the region of the head and neck permits visual observation of the developing reactions and subsidence of the lesion. Initial studies of the relative biological effectiveness of the electron beam [1], and early clinical experience with the beam [2], indicated an approximate equivalence of ⅔ r of the electron beam to 1 r of conventional x-ray having a half value-layer of the order of 2 mm. of copper. We have found no reason to alter this value.

PHYSICAL ASPECTS OF THE BEAM

In its distribution of energy the electron beam is unique [3]. The nearest comparable distribution of energy would be from an ideal interstitial implant of radium or other solid source. No qualitative difference is seen in biological effect between the electron beam and the x-ray, but differences in clinical effect exist which are dependent upon this distribution of energy.

The special characteristics of the electron beam may be summarized as follows:

1. There is nearly equal dosage throughout most of the range of penetration, and a rather rapid drop in dosage beyond this range to a negligible level. Normal tissues deep to the tumor receive no radiation.

2. Surface reaction is not a limiting problem as it is with x-rays. The skin receives essentially the same dose as the deeper tissues about the tumor being treated. While it is not spared as would be the case with supervoltage radiation, it need not be overdosed in order to achieve adequate dosage in the deeper tissues.

3. Intervening bone, between the source of the beam and the tumor, does not cause underdosage of the tumorous tissue beyond because of the excess energy absorbed by the bone. Rather, the ultimate depth of penetration of the electron beam is reduced. The increase of absorption in bone over that in soft tissue is less than with conventional x-rays, although more than with supervoltage radiation [4].

4. Depth of penetration can be varied by varying the energy of the beam: the greater the voltage, the greater the depth of penetration. Unlike x-rays, penetration is independent of the distance of treatment.

Because the output also varies with the voltage, it has been found practical with the betatron to maintain a constant energy of 19 million volts. Such a beam, within a dosage range of plus or minus 10 per cent, penetrates through tissue to a depth of 6.5 cm. There is no energy beyond 9 cm. Depth of penetration is then varied by interposing an absorbing material of tissue density between the beam and the patient. The depth of penetration of the beam is reduced by an amount equal to the thickness of the absorber.

CLINICAL MATERIAL

Certain clinically observable changes of the tissues under treatment can be used for evaluating the effect of radiation without destructive interference with the tumoral bed or the tumor. These changes, as effected by the electron beam, can be correlated with the known changes from other forms of radiation. It is fortunate that these changes in the region of the head and neck have been carefully studied and documented by Wood and Boag [5], incidental to a similar comparative study of the effects of x-rays and teleradium. This study has been useful in supplementing personal evaluation.

Following an initial period of variation in the factors of dosage and time, a standardized technic evolved based on a tentative optimum dose of 8,600 r in six to eight weeks' total time. Allowing for differences in biological effectiveness, this would correspond to our usual practice with conventional x-rays and supervoltage radiation. All treatments to be referred to herein were given with approximately this time-dose relationship. Except for laryngeal fields of about 5 cm. in diameter, field sizes varied between 8 by 9 cm. and 11 by 11 cm. Lesions could be characterized as moderately advanced to extensive, and except for lesions of the vocal cords, were usually associated with metastases to the lymph nodes.

Reactions of the Skin. As with x-ray therapy, the sequence of erythema, dry dermatitis, and in most cases some degree of wet dermatitis is followed as the dosage is increased. Appearance of standard erythema varied with dosage between extremes of 2,000 r to 4,800 r, but in most cases was close to the mean of 3,500 r. This would correspond to about 2,300 r of x-rays. A wet reaction usually did not occur with the administration of less than 7,500 r. Considerable individual variation among patients in severity of the reactions was encountered, necessitating in some cases reductions in the daily dose to avoid gross breakdown of tissue. The time for healing was the same as that for comparable reactions produced by x-rays.

Reactions of the Mucous Membrane. Mucosal reactions provide perhaps the best index for correlating the effects of different kinds of radiation. The reaction occurs at the same depth and in the same tissues as the desired, lethal effect on the tumor. The mean level for appearance of mucositis was 3,600 r, equivalent to 2,400 r x-ray. The range was from 2,100 r to 4,700 r. The lower end of this range is seen with treatment to the palate and anterior part of the tongue; the upper with treatment to the larynx and hypopharynx. This same distribution was noted by Wood and Boag with both x-rays and teleradium. If adjustments are made for relative biological effectiveness in the dosage, no difference in severity or character of the reaction was noted from that seen with x-rays or supervoltage radiation.

Tumoral Regression. Considerable variation occurred in the rate of regression, even in similar sites, so that no generalization is so far possible. Special note should be made, however, that metastatic nodes which were treated in the same field as the primary tumor regressed at the same rate as the primary tumor.

Systemic Status of the Patient. In the ordinary course of radiation of lesions of the head and neck with x-rays or supervoltage radiation, the initial half of the course is a period of increasing comfort as the tumor regresses and infection subsides. During the last third of the period of treatment and for two weeks after the end of the course, there is marked discomfort because of the mucosal reaction and dryness of the mouth. Patients treated with multiple electron beam fields also have this period of intense discomfort. When the treatment, and therefore the reaction, is unilateral, however, the discomfort is very much less and nutritional problems are unusual. It is this ability to reach adequate levels of dosage with minimal involvement of normal tissues and minimal interference with normal functions that is the outstanding advantage of the electron beam.

Complications. The only significant complication has been a delayed healing of the tumoral bed in two of the patients treated recently for

carcinoma of the tonsillar fossa. The delayed healing has led to necrosis and bacterial invasion of adjacent tissues and bone.

Survival. Patients treated more than three years ago were generally selected because their conditions were advanced or hopeless as far as treatment by any other means was concerned. It is remarkable that some have survived. Of eight patients with squamous carcinoma of the tonsillar fossa, one is alive after three years. Of four with parotid adenocarcinoma, one is alive. Of four with squamous cancer of the vocal cords, three are alive. The shorter follow-up period of the more recently treated, unselected patients suggests that results will be quite favorably comparable to alternate therapeutic methods.

CASE REPORTS

CASE I. The patient was a seventy-nine year old man with squamous carcinoma involving the right anterior pillar and adjacent buccal mucosa, of six months' duration. Several metastatic nodes were present in the upper anterior cervical chain. Through an 8 by 10 cm. field, 8,700 r was given in a six-week interval. Moderate moist dermatitis developed externally, reflecting in part the shorter period of treatment. Satisfactory mucositis was obtained. There remained a persistent area of necrosis at the previous tumoral site which has been slowly healing in. At this writing the patient has remained in good health for one year following treatment.

CASE II. The patient was a sixty-three year old man with squamous carcinoma of the left tonsil, of two months' duration. A metastatic node was noted at the angle of the jaw on the left. Through an 8 by 12 cm. portal a dosage of 7,000 r was given in four and a half weeks. Because of the very brisk mucosal reaction and the rapid regression of the tumor, clinical evaluation prevailed and treatment was not carried to higher dosages. The skin showed an early wet reaction. The mucositis at its height was sharply defined and limited to the left half of the oral cavity. At this writing the patient has remained symptom-free for seven months.

CASE III. The patient was a sixty-four year old man with squamous carcinoma of the left anterior pillar of three months' duration. A metastatic node was noted at the angle of the jaw. Through an 8 by 10 cm. field, 8,600 r was given in eight weeks. Mild but satisfactory mucositis was produced with prompt regression of the tumor and the node, and good mucosal healing. The skin showed dry dermatitis only. The patient has remained healthy at this writing for six months.

CASE IV. The patient was an eighty-five year old man with adenocarcinoma of the hard palate present for two years. There were no manifest metastases. Through two opposing 7 by 10 cm. fields, 8,900 r was given in eight weeks, 6,000 r from each field. There was satisfactory mucositis and good primary healing but nutrition became a problem because of the extensive intraoral mucositis. The patient died seven months later of intercurrent disease, possibly contributed to by the debility incident to the radiologic reaction.

CLINICAL COMMENTS

The electron beam is well adapted to treatment of lesions which are unilateral in location and relatively subsurface in depth. Neoplasms of the head and neck which fall into such a category are common. Parotid tumors, tumors of the tonsillar fossa, of the maxillary sinuses, of the tongue, of the buccal mucosa and the gingival margin, or involving a pyriform sinus are examples of suitable types. Treatment can be confined to a single side of the oral cavity or pharynx. Homogeneous dosage is placed throughout the tumor-bearing area, including in most instances the primary routes of lymphatic dissemination. The volume of tissue that must be uselessly treated is considerably reduced.

Although systemic effects of radiation never constitute a problem in radiotherapy on the head and neck, such manifestations as nausea and depression of bone marrow are virtually non-existent when the electron beam is used. The suppression of salivary and mucous gland secretion, which greatly contributes to the discomfort of the patient undergoing conventional or even supervoltage x-ray treatment, is only partial. Thus comfort and nutrition are better maintained.

Most of our patients have been edentulous, or have shown such poor dental hygiene that all remaining teeth were removed prior to starting therapy. One week is allowed for healing before starting treatment. In those younger patients with better oral hygiene, we have followed a policy of removing only those teeth which will be in the field of radiation. This is carried out because the bone receives about 60 per cent greater dosage than the adjacent soft tissue. The rapid dental decay which follows salivary suppression from radiation has not been seen with electron beam therapy to the present time.

Certain midline tumors, such as those of the

larynx or the anterior floor of the mouth, can be reached with a single anterior portal, and the advantages of single field treatment achieved. On the other hand, to reach most midline tumors, such as those of the nasopharynx, epiglottis, posterior part of the tongue, or the hard palate, crossfiring with two or more opposing portals must be used, not only to include the initial routes of lymphatic dissemination in the treated volume of tissue but also to reach the midline primary tumor. With our energy of 19 million volts and allowing for the increased absorption of intervening bone, a homogeneous level of radiation dosage is obtained through the average human head with two lateral opposing portals. But the effect is inferior to that which can be obtained with supervoltage radiation, since the dosimetry is less certain and there is no sparing of the skin and bone.

SUMMARY

1. Electron beam therapy offers important advantages in treatment of subsurface and unilateral cancers of the head and neck.

2. Advantages are derived from the unique distribution of dosage wherein a high homogeneous dose is given to a limited volume of tissue.

3. The advantages of the electron beam depend upon use with a single treatment field.

4. Reactions of the normal tissues and effects on the tumor parallel those seen with other radiation.

5. Short term follow-up of a limited number of patients is encouraging, but evaluation of survival must await further data.

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Bilateral Radical Neck Dissection

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CONVENTIONAL "radical neck dissection" occupies a prominent position in the surgical management of cancer of the head and neck. Although many relatively insignificant technical variations exist, it is as well standardized as any operation and better so than most. There should be no doubt as to the extent of the procedure when the term radical neck dissection is employed; preservation of the internal jugular vein requires classification as modified neck dissection.

In recent years this basic procedure has been extended to include in-continuity resection of the primary lesion. A further extension, in an attempt to salvage the patient with bilateral metastases, merits consideration. Opinions related to management may differ, but the concept that bilateral metastasis constitutes a contraindication to surgical intervention is no longer tenable. Suggested alternatives include one- or two-stage bilateral neck dissection, with or without preservation of one internal jugular vein. Each method has its proponents. We are herein concerned with bilateral neck dissection with excision of both internal jugular veins as a one- or two-stage procedure, depending upon the existing clinical circumstance, i.e., synchronous or metachronous bilateral metastasis to the cervical lymph nodes. Emphasis is placed on the one-stage operation.

HISTORICAL REVIEW

We shall make no attempt to review completely the older literature on bilateral ligation or excision of the internal jugular veins, although it is worth mentioning that Crile recorded a staged bilateral radical neck dissection in 1906. A number of reports appeared about this time but little else was written for several decades.

In our opinion, it is neither logical nor desirable to compare the experiences of the early nineteen hundreds with those of recent years. In the older reports, many of the bilateral interruptions of the jugular veins consisted of ligation only, as for septic thrombosis following mastoiditis, leaving the collateral circulation essentially undisturbed. When bilateral cervical dissection was also accomplished, the extent of the resection was not always precisely stated, but of more importance is the fact that current supportive measures were not then available. We certainly would not recommend complete simultaneous bilateral neck dissection (in conjunction with resection of the primary lesion) without the aid of a skilled anesthetist, a blood bank, antibiotics, tracheostomy, etc. It is not surprising that extensive dissections accomplished under circumstances then existent were accompanied by an appreciable mortality. Although the specific cause of death was not always apparent, it was usually attributed to interruption of the internal jugular veins.

The first published account in recent years appeared in 1951 when Moore and Smith [*14*] reported the first one-stage bilateral neck dissection performed at the Memorial Hospital, New York. The operation was successfully accomplished in August 1950. Morfit [*15*] performed simultaneous bilateral dissection in December 1950, and Perzik [*17*] in June 1949 and December 1950 although his publication was preceded by the two previously mentioned. Beahrs [*4*] performed the first one-stage bilateral operation at the Mayo Clinic in June 1952. All patients survived and serious sequelae were not apparent. It is likely that many patients have been treated since with simultaneous bilateral procedures,

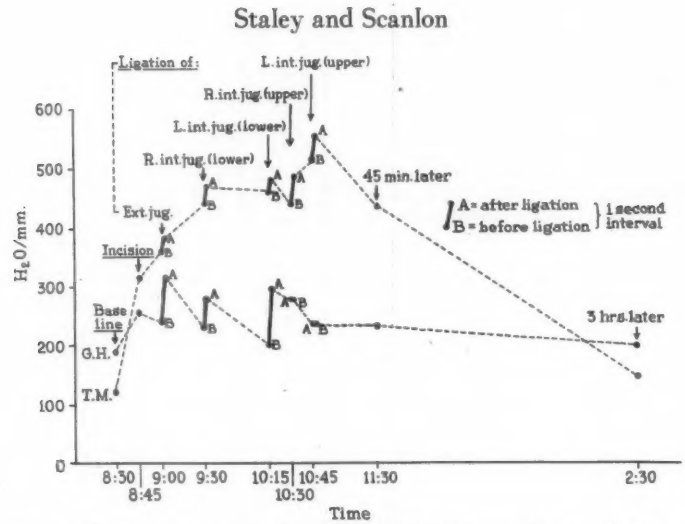

FIG. 1. Alterations in pressure of cerebrospinal fluid in two patients undergoing simultaneous laryngectomy and bilateral radical neck dissection.

but few, if any, additional reports have appeared.

COLLATERAL CIRCULATION

The greatest deterrent to true bilateral radical neck dissection, either as a single or multiple stage procedure, has been the fear of excision of both internal jugular veins. This fear is based more on exaggerated ideas of the potential sequelae, perpetuated by repetitious quotation of exotic complications, than on actual accumulation of catastrophic experiences.

Bilateral radical neck dissection implies bilateral sacrifice of the anterior, external and internal jugular veins; remaining vascular channels must therefore acquire a greater functional significance. The potential adequacy of the remaining venous network may be noted by reviewing a standard text on anatomy; the reviewer is soon impressed by the number of remaining vessels if not by their individual magnitude.

Following bilateral resection of the jugular veins the vertebral venous system undoubtedly plays the most important role. Batson [*2,3*] has repeatedly emphasized the significance of the vertebral plexus and has estimated that the cross sectional area exceeds that of the internal jugular veins [*2*]. This plexus provides a mechanism for venous compensation following bilateral resection of the internal jugular veins. It is said that following death from hanging the brain appears anemic while the face is markedly congested [*18*]. This would testify to the adequacy of the vertebral plexus as an outflow tract for the cerebral blood.

The deep cervical and occipital veins and the pharyngeal, pterygoid and esophageal plexuses offer additional avenues of venous return. The emissary vessels provide direct communication between the dural sinuses and the vessels outside the skull. These include the parietal, occipital, mastoid, condyloid, hypoglossal, pharyngeal, ophthalmic and ethmoid veins. Although each is small and marked dilatation is precluded by the course through the skull, their combined size is such that they should not be considered insignificant. Many of these vessels, directly or indirectly, are tributaries of the vertebral plexus; thus the system provides drainage for the extracranial as well as the intracranial structures. In the absence of some vascular anomaly sufficient channels remain for the exit of blood from inside the skull and its subsequent return to the heart. With few insignificant exceptions there are no valves in the veins of the head and neck and blood may flow in either direction [*3*].

Many previously unmentioned venous channels, superficial and deep, will be directly or indirectly interrupted during bilateral neck dissection, especially when associated with concomitant removal of the thyroid, cervical esophagus and/or larynx. It seems unlikely that excision of the superficial vessels is of great importance in view of the extensive col-

lateral circulation of the facial area, although Perzik has suggested that ligation of the anterior facial vein blocks the return of blood from the intracranial structures by way of the cavernous sinus and ophthalmic vein. Intermediate communicating channels certainly provide some compensation under these circumstances.

CEREBROSPINAL FLUID PRESSURE

Several investigators [*15,19–21*], have recorded alterations in the pressure of the cerebrospinal fluid during the course of radical neck dissection but opinions differ regarding their significance. The pressure-elevating effect of straining, coughing, etc. is generally recognized; it is less well known that ether anesthesia [*21*] and turning the head to either side [*20*] have a similar effect.

Schweizer and Leak [*20*] noted an elevation to 400 to 600 mm. of water, or more, in most of their patients during unilateral radical neck dissection; changes of similar magnitude occurred during bilateral dissections whether performed simultaneously or in separate stages. Within a few days of surgery the pressure of the cerebrospinal fluid was usually within normal limits.

Sugarbaker and Wiley [*12*] noted a normal response to the Queckenstedt maneuver on compression of the cervical musculature several weeks after the second stage of complete bilateral neck dissection; a similar observation was made by Royster [*19*], on compression of the operated side following unilateral dissection.

Figure 1 demonstrates changes in pressure of the cerebrospinal fluid in two patients undergoing simultaneous laryngectomy and bilateral radical neck dissection. It will be noted that the pressure varies appreciably and assumes a not insignificant level even before the first internal jugular vein is ligated. It will also be noted that there is no dramatic change following ligation of the second internal jugular vein even though the ligations were accomplished within a few minutes of each other (two surgical teams were working simultaneously). That the changes are usually transient has been noted by others and is demonstrated here by the decline to preoperative values within three hours. The increase in the pressure of the cerebrospinal fluid accompanying the turning of the head to the side also occurs after bilateral excision of the internal jugular veins. Several segments from a strain-gauge manometer

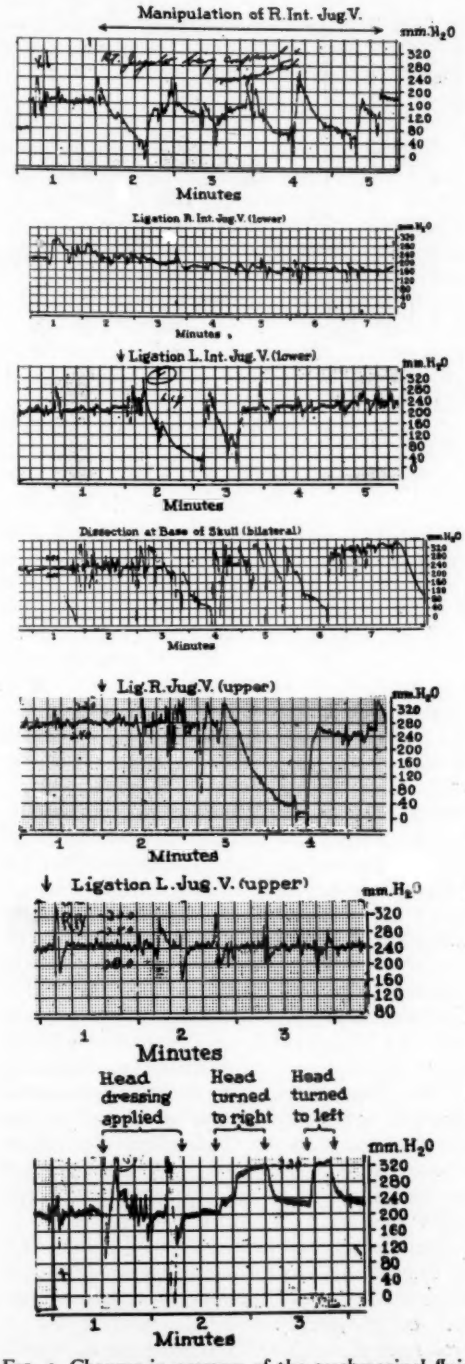

FIG. 2. Changes in pressure of the cerebrospinal fluid (segments of strain gauge tracing) during bilateral radical neck dissection and laryngectomy.

tracing on a patient undergoing simultaneous bilateral neck dissection are presented in Figure 2.

CHOICE OF PROCEDURE

Bilateral metastases to the cervical lymph nodes may be present when the patient first comes to the attention of the surgeon; or, involvement of the second side may become apparent after a unilateral neck dissection has been accomplished. In the latter circumstance the operations will of necessity be performed in separate stages; in our opinion the second dissection should be complete, but preservation of the internal jugular vein on the second side has been recommended.

There is greater conflict concerning the course to be followed when bilateral metastases are present initially. The majority of authors have indicated a preference for staging the operative intervention under these circumstances also. Although estimates vary as to the most desirable interval a period of two to six weeks is usually suggested. It is a common belief that with the longer intervals there will be fewer undesirable sequelae. Our experience does not support this contention. Theoretically, collateral circulation is developing during this time, thereby reducing the risk of the second operation. That an expansion of the capacity of collateral venous channels actually occurs following unilateral dissection has to our knowledge not been established. We have not encountered impressive evidence of such in performing neck dissections on the second side many months after the first, although at times the larger vessels seem somewhat more prominent than usual and venous bleeding appears to be increased. (We are aware that the most important collateral channels would not be encountered in this dissection.) Moreover, we have seen as much facial congestion in two-stage procedures as in simultaneous dissections; in fact in our most severe instance the interval between operations was seven months. Others [*1,5,9,17,21*], have commented on the relatively severe congestion that may follow two-stage operations.

Preservation of the internal jugular vein on the second side, instead of or in addition to staging the two dissections, has been recommended [*1,6,10,13*]. Without entering into a prolonged discussion of the necessity of jugular excision as a component of the conventional radical neck dissection (a fact accepted by all when metastases are unilateral), it would seem apparent that if such excision is essential to the first dissection it should be considered essential to the second. Preservation of the internal jugular vein during an otherwise classic radical neck dissection is technically feasible if the adenopathy is not extensive, but it is debatable that the attempt should be made even then. The anatomic and pathologic relationships are not analogous to the relationship of the axillary vein and radical mastectomy as suggested by some.

It is obvious that in certain patients with simultaneous bilateral metastases the operation cannot be staged without violating the surgical field; for example, extensive metastases to the submental lymph nodes and bilateral metastases to the jugular lymph nodes from cancer of the lip or floor of mouth, or thyroid or laryngeal cancer with bilateral metastasis to the cervical lymph nodes. In these and other instances tumor-bearing tissue or potentially tumor-bearing tissue would have to be transected in order to perform the resection at separate séances. If it is essential to perform neck dissection in continuity with the primary lesion when the metastases are unilateral, is it not essential also when the metastases are bilateral?

Barbosa [*1*] and Bocca [*5*] have suggested that simultaneous bilateral neck dissection can be safely accomplished only when massive involvement of the lymph nodes has produced significant compression or actual occlusion of one or both internal jugular veins. That this is not the case is demonstrated in the small series reported herein, as the adenopathy has always been minimal on the second side and was usually not massive on either side.

PRESENT SERIES

That bilateral metastasis to the cervical lymph nodes occurs with considerable frequency is demonstrated in this series. Since the Veterans Administration Research Hospital was activated approximately five years ago, sixty-eight radical neck dissections have been performed. During this period there have been nine bilateral dissections, four one-stage, and five two-stage procedures. A considerably greater number of patients with bilateral metastases were seen whose disease was too far advanced for attempted surgical removal. Martin [*11*] reported bilateral operations in

TABLE 1
BILATERAL RADICAL NECK DISSECTION

Patient and Age (yr.)	Primary Site*	Date(s) of Surgery	Pathologic Condition of the Lymph Nodes†		Post-operative Congestion	Post-operative Edema	Current Status‡
			Right	Left			
One-Stage Procedure							
2332 (62)	Larynx	4/5/55	1/69	4/73	++	++++	Living and well, 49 mo.
3008 (59)	Floor of mouth	6/23/55	0/40	0/39	++	+	Living and well, 47 mo.
12921 (46)	Larynx	10/23/58	3/75	5/71	+	+−	Living and well, 7 mo.
13779 (69)	Larynx	3/9/59	4/73	4/71	0	+	Living and well, 2 mo.
Two-Stage Procedure							
2422 (58)	Floor of mouth	4/8/55 8/9/55	4/72	3/39	+++	+++	Living and well, 45 mo.
9646 (67)	Larynx	9/17/57 4/13/58	2/53	12/37	+	++	Living and well, 13 mo.
9669 (67)	Cervical esophagus	11/12/57 9/18/58	3/16	5/26	+	+	Living and well, 8 mo.
10387 (60)	Tongue	11/26/57 3/4/58	6/26	1/29	+	++	Dead, 6 mo.
11592 (66)	Larynx	5/22/58 12/18/58	1/33	1/38	+++	+++	Living and well, 5 mo.

* All primary lesions were treated surgically.
† Number of positive nodes/number of nodes sectioned.
‡ Time between last operation and May 1959.

sixty-six of 599 patients undergoing radical neck dissection.

When patients present with bilateral metastasis to the cervical lymph nodes in association with a resectable primary lesion, simultaneous dissection is accomplished. Staged procedures are utilized only when metastases develop on the second side following a previous radical neck dissection. Clinical evidence of bilateral metastases was present in all patients; histologic confirmation was obtained in all but one. We do not perform bilateral dissections prophylactically. Although the prognosis may be relatively poor, the procedure is performed with intent to cure.

Pertinent data referable to the nine bilateral neck dissections are presented in Table 1.

All one-stage dissections have been carried out with two surgical teams operating simultaneously. The procedure is therefore not unduly prolonged even though the primary lesion is resected concomitantly, but accurate replacement of blood loss is obviously essential.

In our opinion, tracheostomy is mandatory, whether the dissection is performed in one or two stages. One should not risk respiratory embarrassment secondary to laryngeal and/or lingual edema; that it may follow either simultaneous or staged procedures should be recognized and precautions taken.

Postoperatively, the head of the bed is elevated to 30 degrees or more. This position is well tolerated by the patient and may facilitate venous return. Activity is permitted as desired. We have not performed "therapeutic" spinal punctures in any case, although studies on the pressure of cerebrospinal fluid have been carried out during operation in a few patients. Several authors [*15,19,21*], recommend insertion of a spinal subarachnoid catheter before bilateral dissection in order to make frequent checks of the pressure of the cerebrospinal fluid and withdraw fluid if significant elevation occurs. We do not consider this essential.

There have been no postoperative deaths

FIG. 3. Preoperative and postoperative (three month) appearances; bilateral radical neck dissection and laryngectomy.

in this small series and morbidity has been minimal. Martin [12], speaking from a greater experience states, "there is no increase in postoperative mortality or disability that can be ascribed to the removal of the second internal jugular vein." In view of the magnitude of bilateral neck dissection one would anticipate a somewhat greater mortality than with unilateral dissection but the patient's life is at risk on only one occasion instead of two.

SEQUELAE

During the final stages or immediately following bilateral radical neck dissection the face may be moderately to markedly discolored. If the surgeon is unaware of this possibility he may view it with considerable apprehension as the husky purplish hue may be confused with cyanosis of respiratory origin. That it is due to congestion is readily demonstrated by its limitation to the face, an observation which may be obscured temporarily by the surgical drapes. Significant facial cyanosis is *not* a constant accompaniment of bilateral resection of the jugular veins. It may follow staged operations as well as the simultaneous procedure and does not necessarily occur after either. We have noted a similar appearance many times in the past on application of a pressure dressing following unilateral neck dissection. It is not unlikely that the dressing effectively compressed the major venous channels of the side which was not operated upon and in essence had the effect of bilateral dissection.

FIG. 4. Surgical specimen, patient seen in Figure 3.

FIG. 5. Surgical specimen. Bilateral radical dissection of the neck with resection of anterior two-thirds of the tongue and horizontal rami.

A considerable degree of facial edema will develop in the majority of patients. This occurs shortly after or even before the operation is terminated, may progress during the next few days, and gradually improves thereafter. In our experience postoperative edema has varied from almost none to a ballooning of the face so extensive that the eyelids could not be separated; the patient was recognized with difficulty. With the passage of time, improvement is such that the swelling cannot ordinarily be considered a cosmetic liability, but slight to moderate edema of the lower portion of the face may persist indefinitely (Figs. 3 through 5.) Whether this is a result of venous or lymphatic deprivation is a subject of some debate. The edema is limited to the tissues above the transverse portion of the incision; a similar although more transient and less severe homolateral edema of the lower part of the face not infrequently follows uni-

lateral dissection; bilateral edema of the lower part of the face may follow the so-called bilateral upper neck dissection in which the internal jugular veins are not disturbed; these facts indicate that the edema is of lymphatic origin.

In the hope of minimizing postoperative edema we have applied snug compression dressings to the entire head and neck following simultaneous bilateral neck dissection, a practice avoided by some because of the possibility of venous compression. In one patient the dressing was removed on the second postoperative day at which time very little edema was present; it was not reapplied and during the next few days edema increased but was almost completely eliminated by the reapplication of the dressing.

Many patients complain of a deep-seated headache but this also occurs occasionally following unilateral dissection. It is usually aggravated by the assumption of a recumbent position and may be improved or eliminated by elevating the head of the bed, sitting or standing. Within a few days or weeks marked improvement will occur but a feeling of tightness about the face may persist even in the absence of significant facial edema. The exceedingly rare persistent increase in intracranial pressure associated with headache and visual disturbance as noted by Morfit and Cleveland [*16*] following unilateral neck dissection has not occurred in this small series.

Minimal necrosis of the margins of the skin flaps has been a cause of some apprehension in view of its location near the carotid vessels but prophylactic or emergency ligation of the carotid vessels has not been necessary.

SUMMARY

The management of the patient with bilateral metastases to the cervical lymph nodes has been discussed. Nine patients were subjected to complete bilateral radical neck dissection, four of which were performed in one stage, without operative mortality or serious postoperative morbidity. No significant complications attributable to venous engorgement or increased pressure of the cerebrospinal fluid have been noted. Simultaneous bilateral radical neck dissection is a procedure of limited applicability, but is fully justified in selected patients with potentially curable bilateral metastases to the cervical lymph nodes.

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Malignant Tumors of the Head and Neck

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THE head and neck is a complex area with a wide variety of organs and tissues. This discussion is limited to three general zones: (1) the mouth, including the lips, cheeks, gums, floor of mouth, palate, tongue, tonsils and oropharynx; (2) the nose, including the nasal cavity, paranasal sinuses and nasopharynx; and (3) the neck, including the larynx, salivary glands, thyroid and lymph nodes. The discussion is also limited mainly, but not exclusively, to the malignant epithelial tumors of these organs and tissues.

THE MOUTH

Cancer of the mouth accounts for about 4 to 5 per cent of all cases of cancer and about 75 per cent of the cancers of the upper respiratory and alimentary tracts. Males are affected five to nine times as frequently as females. Cancer of the lip and floor of the mouth occurs almost exclusively in men. Cancer of this area, while it can occur at any age, predominates in persons between the ages of forty and seventy, is more common in white persons than Negroes, and is often preceded by or associated with keratoses or leukoplakia. Persistent chronic irritation associated with exposure to sunlight (lips), syphilis (tongue), vitamin deficiency, smoking, broken teeth or ill-fitting dentures may play a contributing role in the development of cancer of the mouth.

Grossly, carcinoma of the mouth may be single or multiple, may begin as a papule, indurated plaque, nodule, fissure or blister which can crust and finally ulcerate. The fully developed lesions are either flat or fungating. The size of the lesion is dependent upon the rate of its growth and duration. The usual lesion measures from 1 to 4 cm. in diameter but some measure only millimeters in size. The flat lesions have central ulcerations with sloping or slightly undermined edges. In most patients there is an indefinite infiltration of adjacent tissue. The fungating lesions are sessile, firm gray-white, at times pedunculated and covered either by intact mucosa or irregularly superficially ulcerated. The lesion is firmly anchored to the submucosal structures and irregularly infiltrates the adjacent tissues at the base. Some lesions project as large cauliflower-like masses pushing aside normal structures, and some appear as extensive ulcerated craters destroying soft tissues and bones of the jaw.

Metastases generally from cancers of this region are confined to the cervical lymph nodes, but in advanced cases spread to the lungs, liver, bone and other viscera. The spread is usually by direct extension involving mucosa, submucosa, muscle and bone. Death is usually due to sepsis, malnutrition, dehydration, hemorrhage from erosion of blood vessels, respiratory obstruction and in advanced cases from local and distant metastases. It should be pointed out that enlargement of the regional lymph nodes can be the result of infection as well as tumor. Generally speaking, the prognosis is better the nearer the cancer is to the lips, and worse the nearer it is to the pharynx. Prognosis is also, of course, dependent upon the size, duration and differentiation of the tumor and whether or not there are metastases. The predominant carcinoma occurring in this region is the squamous cell or epidermoid carcinoma which arises from the squamous epithelial mucous membrane lining the oral cavity. Other tumors that occasionally occur here are the adenocarcinoma which arises either from minor salivary glands or mucous glands and most often from the palate, and the transitional cell carcinoma or lymphoepithelioma which in this region arises mainly from the base of the tongue, tonsils and pharynx. Since the transitional cell carcinoma is the characteristic malignant epithelial tumor occurring in the nasal region, it will be dis-

cussed later with that group. Other tumors rarely seen are the malignant melanoma, malignant mucoepidermoid tumor, plasmacytoma discussed with nasopharynx, malignant lymphoma and undifferentiated sarcoma. The predominant malignant lymphoma in this region is the lymphosarcoma. This tumor most often involves tonsils and pharyngeal lymphoid tissues, but can also involve the base of the tongue and gingiva. Grossly, these tumors form bulky soft cellular masses which may be associated with tremendous bilateral enlargement of the cervical lymph nodes. Most cancers of the mouth are microscopically well differentiated and, as a rule, the less well differentiated tumors occur posteriorly while differentiation increases anteriorly.

The predominant well differentiated squamous cell carcinomas microscopically consist of strands, masses, nests and sheets of neoplastic obvious squamous epithelium and/or cells streaming from the mucosal epithelium into the submucosa and underlying tissues. The nests of tumor cells are generally sharply defined; the cells are large polyhedral prickle cells; there may or may not be keratin pearls; and mitoses, although present and obvious, are not particularly numerous. The undifferentiated squamous cell carcinomas consist of cords, nests or single cells irregularly infiltrating the subepithelial stroma. The cells may be polyhedral-shaped and resemble squamous cells, or may be hardly recognizable as squamous cells, resembling more the undifferentiated cells of a round or spindle cell sarcoma. The cells can vary considerably in size, shape and staining character and mitoses may be numerous and abnormal. The stroma varies from loose edematous to dense fibrous tissue infiltrated with plasma cells, lymphocytes and neutrophils. (Figs. 1 to 3.)

The adenocarcinoma of this region microscopically consists of epithelial cells in vague or well defined gland formations or merely columnar cells haphazardly arranged. The acini may or may not contain mucin. The cells have large round nuclei with abundant chromatin dispersed throughout the nucleus. The stroma is fibrous or hyaline. The cylindromatous or adenoid cystic type of adenocarcinoma is similar to that seen in the nose and arising in the salivary glands, and will be described under salivary glands.

Before proceeding to the various subdivisions of the mouth, I briefly would like to make some

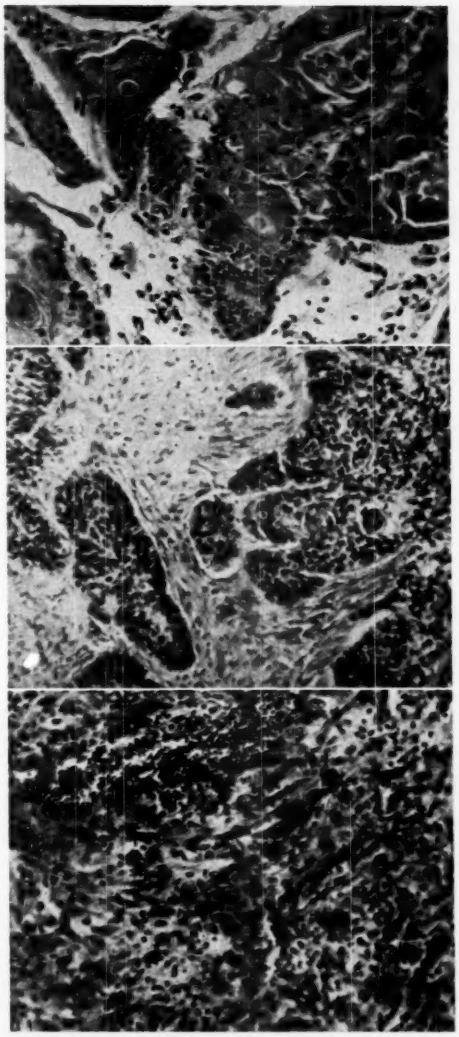

FIG. 1. Moderately well differentiated squamous cell carcinoma.

FIG. 2. Moderately undifferentiated squamous cell carcinoma.

FIG. 3. Highly undifferentiated squamous cell carcinoma resembling a sarcoma.

remarks and give the histologic features of leukoplakia, carcinoma *in situ* and adamantinoma.

Leukoplakia, clinically, is a white patch or network which pathologically can be a number of things varying from lichen planus to squamous cell carcinoma. Pathologically leukoplakia of the so-called precancerous connotation shows

epithelial hyperplasia with hyperkeratosis or parakeratosis, basal cell hyperplasia with foci of atypical changes and a subepithelial subacute or chronic inflammatory cell infiltrate. Leukoplakia most frequently is seen in the buccal gingival gutter. Few actually progress to outspoken carcinoma but, on the other hand, many carcinomas are associated with leukoplakia.

Carcinoma *in situ*, which has become a popular diagnosis in many regions of the body, also occurs in the mouth. Microscopically the epithelium shows the atypical changes of carcinoma; these changes are confined to the epithelium. It is not known how frequently this lesion goes on to the development of outspoken carcinoma nor at what rate it develops. It may appear in several areas and can be present at the edge of outspoken carcinoma.

The adamantinoma or ameloblastoma, while not truly a malignant tumor, is a locally extending and recurring tumor that on rare occasions does metastasize. It is an epithelial tumor arising from cells with a potential for forming the enamel organ of the tooth. It arises in the mandible at the junction of the body and ramus, and expands and deforms the bone. It occurs mainly in men about thirty-five years of age. Microscopically there are variable sized epithelial masses, peripherally outlined by a palisade of dark-staining columnar epithelial cells and centrally stellate-shaped epithelial cells. Sometimes the central epithelial masses degenerate, fluid accumulates and cystic as well as solid variants form. Squamous metaplasia is rarely seen, as is true gland formation. Melanin is very seldom present in the epithelial cells.

The most common site of carcinoma in this region is the lower lip. Intraoral carcinomas involve, in the order of decreasing frequency, the tongue (in over 50 per cent of patients), the floor of the mouth, gums, palate and buccal mucosa.

Lips. Squamous cell carcinoma predominantly involves the lower lip at the vermilion or mucocutaneous junction in older (sixty year old) white men. In Scandinavian countries females are involved in as much as 16 per cent of cases as compared to about 2 per cent in this country. Most of the squamous carcinomas are well differentiated. Adenocarcinoma of the lips is rare, and even rarer are malignant melanoma and fibrosarcoma. Metastases are to the lymph nodes of the submental and submaxillary groups and then to the jugular chain of nodes. More distant metastases are rare. The prognosis for squamous cell carcinoma of the lip is in the neighborhood of 70 to 90 per cent for five-year survival.

Buccal Mucosa. Carcinoma of the buccal mucosa is less than half as common as carcinoma of the tongue and also occurs predominantly in older men (fifty-eight years), but even teenagers can be affected. Metastases are to lymph nodes in the submaxillary triangle. Five-year survival is in the vicinity of 30 per cent. Metastases can occur early and extension can be very wide.

Tongue. Carcinoma of the tongue also predominates in the forty to sixty year old man, and is most commonly located on the upper lateral edge of the middle third (58 per cent) and base (33 per cent) of the tongue. The tongue is second only to the lips in frequency as the site of cancer of the mouth.

The carcinomas at the tip of the tongue are generally well differentiated. Those at the base are undifferentiated. The prognosis is better at the tip and worse at the base. Metastases are to deep cervical lymph nodes adjacent to the bifurcation of the common carotid artery. These tumors are more malignant than those of the lip and cheek. The carcinomas at the base of the tongue and the floor of the mouth have the worst prognosis of tumors of this region. The over-all general five-year survival rate for carcinoma of the tongue is 25 to 35 per cent.

Floor of Mouth. Carcinoma of the floor of the mouth is about half as common as carcinoma of the tongue, predominates in men, and has a five-year survival rate of about 20 per cent. Metastases are to sublingual, submaxillary and jugular lymph nodes.

Gums. About 10 per cent of carcinomas of the mouth involve the gums. Ninety per cent are squamous cell carcinomas and the rest are adenocarcinomas, malignant melanomas, malignant lymphomas and adamantinomas. The average age of occurrence is sixty years, and the ratio of males to females is about 5:1. Both upper and lower gums are involved, and at least 60 per cent of these carcinomas occur in the region of the third molar, the rest in the region of the bicuspid and canine teeth. The five-year survival rate is in the range of 25 to 30 per cent.

Palate. Eight per cent of cancers in the oral cavity involve the palate; 75 per cent of these are squamous cell carcinomas and the rest are

mainly adenoid cystic adenocarcinomas (see salivary gland). It is interesting that the ratio of male to female for squamous cell carcinoma is about 9:1, while adenocarcinomas occur with equal frequency in men and women. The average age for epidermoid carcinoma is about sixty years, while that for adenocarcinoma is about forty-eight years. The squamous cell carcinomas in this area grow rapidly, and grow early into bone and other adjacent structures, the nasal cavity and sinuses. Death occurs usually in a year to a year and a half after the diagnosis is established. The adenocarcinoma grows slowly, rarely ulcerates and infrequently erodes or extends into bone. Death occurs as a result of metastases in about five years rather than from local effects as is the case with epidermoid carcinoma.

Tonsil. Carcinoma of the faucial tonsil also predominates in males, can develop on the basis of or be associated with leukoplakia, affects older men (usually about sixty years of age), is about half as common as is carcinoma of the lip, and makes up about 2 per cent of all human cancers and about 8 per cent of cancers of the upper respiratory and alimentary tracts. The carcinoma can involve either side but is usually unilateral, and can arise from the anterior or posterior pillars or tonsillar fossa. The predominant malignancies of the tonsils are squamous cell carcinoma (85 per cent) and malignant lymphoma (15 per cent). Transitional cell carcinoma or lymphoepithelioma can also arise here, but will be discussed with tumors of the nasopharynx.

The squamous cell carcinomas of the tonsil are generally undifferentiated, can be flat, ulcerated or fungating, or can superficially spread extensively. The spread is to the mouth and hypopharynx, and metastases are to deep cervical nodes. The prognosis is poor, and the five-year survival rate ranges from 15 per cent to as low as 5 per cent in some series.

Pharynx. The tumors arising here are similar to those of the nasopharynx, and will be discussed with tumors of that region.

THE NOSE

The nose, including the nasal cavity, paranasal sinuses and nasopharynx, is the site of 2 per cent of carcinomas of the body.

The malignant epithelial tumors found in this area are transitional cell carcinoma and squamous cell carcinoma, which in this area is a transitional cell carcinoma with squamous differentiation and adenocarcinoma. The predominant malignant epithelial tumor found in this region is the transitional cell carcinoma which arises from the so-called "schneiderian" upper respiratory tract columnar mucosal epithelium of the nose and paranasal sinuses and from the so-called columnar lymphoepithelial mucosal epithelium of the nasopharynx. These tumors have a great tendency toward squamous differentiation and may be completely squamous especially in the nose and paranasal sinuses and less in the nasopharynx. Adenocarcinoma is also seen but is less common and less malignant than either the transitional cell carcinoma or squamous cell carcinoma. The tumors of this region are most common after thirty years of age, can involve persons of all ages and predominate in men. Carcinomas of the nasal cavity and paranasal sinuses metastasize less freely than do those arising in the nasopharynx, and tend to involve large portions of contiguous structures by invasion and pressure atrophy.

In the order of decreasing frequency carcinomas involve: the nasal cavity, nasopharynx, and the maxillary, ethmoidal, frontal and sphenoidal sinuses. The maxillary sinus is more commonly involved than are all the other sinuses together, and in the maxillary sinus the squamous cell carcinoma predominates.

Carcinomas of this region arise from respiratory epithelium and are generally characterized by aggressive local behavior. Distant metastases are less common than carcinomas generally, except for the nasopharynx in which tumors occur in a younger age group and metastasize early to regional lymph nodes which indeed may be the first indication of a tumor.

The transitional cell carcinoma arises from respiratory columnar epithelium, and consists of strands, nests or irregular clumps of generally uniform but undifferentiated small polygonal epithelial cells with a small amount of cytoplasm and round, relatively large, evenly darkly stained nuclei. These undifferentiated epithelial cells are often intermingled with the existing lymphoid tissue, particularly in the nasopharynx, and then the lesion is called a lymphoepithelioma or Schmincke tumor. These tumors, particularly in the nasal and sinus cavities, can be papillary (schneiderian papillary carcinoma). The admixture in lymphatic tissue

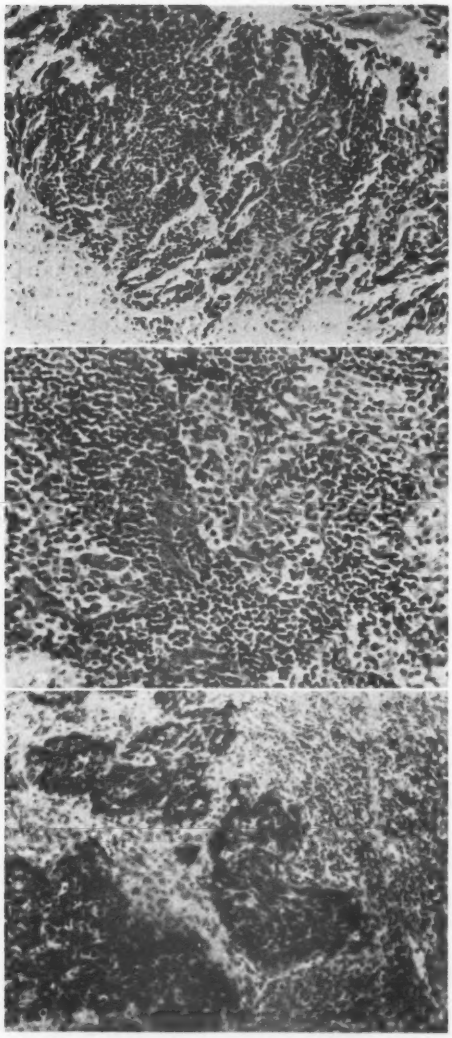

FIG. 4. Transitional cell carcinoma showing proliferation of uniform small dark cells.

FIG. 5. Transitional cell carcinoma with rich admixture of lymphocytes; lymphoepithelioma type.

FIG. 6. Transitional cell carcinoma with nests of tumor cells and very little lymphoid stroma.

can be in the form of palisaded cells growing in ribbon-like fascicles (Regaud type of lymphoepithelioma) or densely cellular, diffusely and haphazardly admixed with lymphatic tissue; at times there may be little or no lymphatic admixture (Schmincke type of lymphoepithelioma). (Figs. 4 to 6.)

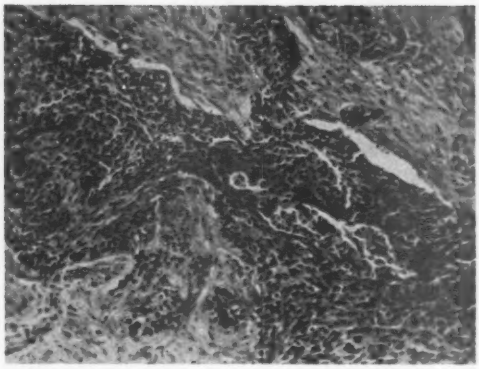

FIG. 7. Transitional cell carcinoma with squamous cell differentiation.

A word of explanation concerning lymphoepithelioma may be pertinent at this time. Lymphoepithelioma has been regarded at various times and by various observers as a transitional cell carcinoma with non-neoplastic stromal admixture, a transitional cell carcinoma-sarcoma, and an anaplastic epidermoid carcinoma. In my opinion, it is a transitional cell or undifferentiated carcinoma arising from respiratory columnar epithelium and is admixed with existing non-neoplastic lymphoid stroma. It is true, however, that this tumor is at times difficult to separate histologically from anaplastic squamous cell carcinoma, lymphosarcoma and reticulum cell sarcoma with any of which it can easily be confused and misdiagnosed.

The squamous cell carcinomas of this region can be well or poorly differentiated. Those in the posterior regions are generally very poorly differentiated. The squamous cell or epidermoid carcinomas arise from columnar epithelium of the upper respiratory tract and, in my opinion, are transitional cell carcinomas with more or less squamous cell differentiation. In the nose and sinuses there is a great variation in these tumors with all degrees of admixtures of undifferentiated transitional cells and squamous cells. (Fig. 7.) This is in contrast to the nasopharyngeal tumors which are more uniformly undifferentiated transitional cell carcinomas. It should be mentioned here that many observers regard the transitional cell carcinoma of this region as merely an undifferentiated anaplastic epidermoid carcinoma. Carcinomas of the pharynx below the palate,

i.e., oropharynx and hypopharynx, are frankly squamous cell carcinomas.

The adenocarcinoma is the least common tumor of this region and is seen in the nasal cavity and paranasal sinuses, and very rarely in the nasopharynx. It arises from mucous glands and often is of the cylindroma or adenoid cystic type seen in the salivary glands, but can be of almost any pattern even resembling adenocarcinomas of the bowel. These tumors are generally of a low grade of malignancy, tend to spread to adjacent structures only late, erode, destroy and cause pressure atrophy, and finally metastasize to cervical lymph nodes and more distant areas (lungs, bone and liver). Those in the nose and sinuses are better differentiated and are localized longer than those arising in the nasopharynx.

Nasal Cavity. Carcinomas of the nasal cavity are generally unilateral and originate from the septum or high on the lateral wall. Grossly, these tumors are either ulcerating or fungating polypoid pink-gray masses which bleed easily. The incidence is similar to that of carcinoma of the palate, about 8 per cent of oral cancers, and also predominates in older men. The predominant carcinoma is the squamous cell carcinoma or perhaps better the transitional cell carcinoma with varying degrees of squamous differentiation. Pure diffuse and papillary transitional carcinomas also occur. About 15 per cent of carcinomas arising in the nose are adenocarcinomas.

The nasal carcinomas usually cause death by local complications, such as hemorrhage, pansinusitis, erosion of adjacent structures with meningitis and brain abscess. The over-all five-year survival rate is about 20 per cent. Metastases are found in about 30 per cent of the fatal cases.

A special tumor of the nose is the epithelial papilloma. It is so designated because although all papillomas are epithelial this one is not so obviously papillary, has a characteristic histology and important biologic behavior. Grossly, it is either papillomatous, polypoid or verrucous but firmer, thicker and rougher than the usual nasal polyp, and causes nasal obstruction rather than bleeding as is the case with the more usual nasal polyps. These tumors occur in adult males arising usually from the middle turbinate toward the posterior portion of the nasal cavity, at times from the septum and occasionally in a sinus. Sometimes they are multiple. Histologically, it consists of thick layers of stratified transitional epithelium in which can be differentiated cuboidal, columnar or frankly squamous cells. The intraepithelial changes can be almost of the *in situ* type of carcinoma. The basement membranes are intact, however. There may be evidence of dyskeratosis and hydrops of individual cells, and minute intraepithelial infiltrates of granulocytes. Biologically, these tumors have a great tendency to continually recur and, some believe, to become eventually outspokenly malignant.

Paranasal Sinuses. The most common site of carcinoma of the paranasal sinus is in the maxillary sinus. Carcinoma arising in the sinuses usually progresses and tends to extend into the nasal cavity. Carcinomas of the sinuses are rather infrequent: about 0.2 per cent of all human cancers and about 3 per cent of cancer of the upper respiratory and alimentary tracts. Males predominate, and the age range is from sixty to seventy years with a median of fifty-four years. The tumors are usually unilateral and more commonly arise in the maxillary sinus than in all others combined. They are polypoid, bulky and fungating, fill the sinuses with a friable pink-gray mass and erode their walls, erode, invade and displace contiguous structures, and are associated with cellulitis and septicemia. Death, as in tumors of the nasal cavity, is usually due to local extension of the disease. Metastases are late and are usually not seen since the patient dies before metastases can appear. An approximate five-year survival rate is 10 per cent.

Microscopically, the tumors are predominantly undifferentiated squamous cell carcinomas or transitional cell carcinomas with predominant squamous cell features. Some tumors are mixtures of neoplastic squamous cells, transitional cells, cuboidal cells and even mucus-secreting columnar cells. Some tumors of the sinuses defy categorization. Rarely does an adenoid-cystic carcinoma of the salivary gland type arise in a sinus.

Nasopharynx. The most common tumor of the nasopharynx is the transitional cell carcinoma. It originates as a small flat nodule in the region of the eustachian tube orifice and can occlude it, spreads widely beneath the mucosa without ulcerating, and occasionally is polypoid. The tumor can extend into the middle ear and to the great ring of the sphenoid bone, and

can erode into the oral cavity. Metastases are to lateral retropharyngeal lymph nodes and to the deep cervical chain along the anterior border of the sternocleidomastoid muscle. When admixed with lymphocytes, as described previously, this tumor is known as lymphoepithelioma. This tumor occurs in persons of a younger age than do other tumors of this region (age range is twenty to sixty-nine years), predominates in males, is four times as common in men as in women and has a predilection for Oriental people. The tumor can grow silently and the first evidence may be enlarged cervical lymph nodes. Microscopically the transitional cell carcinoma that arises in the nasopharynx does not show the striking variations seen in either the nasal cavity or paranasal sinuses. Similar transitional cell carcinomas can arise in the palate, sinuses, tonsil, base of tongue and oropharynx. In the tonsil it may be polypoid or verrucal and extends into the nasopharynx, even to occluding it partially. Rarely it may arise from the respiratory epithelium of inclusions or cysts of the branchial cleft. Again caution should be used since most such lesions are metastases from a silent lesion in the nasopharynx.

Other malignancies that primarily arise in the nasopharynx are anaplastic undifferentiated squamous cell carcinoma, malignant melanoma and adenocarcinoma (at times of the adenoid cystic type), osteogenic sarcoma and plasmacytoma.

Plasmacytoma is a particularly interesting lesion that frequently arises in the upper air passages, most commonly in the nasopharynx but also in the nasal cavity, paranasal sinuses, tonsils, palate, gingiva, uvula, epiglottis, and extremely rarely in the tongue and floor of the mouth. About 80 per cent of cases occur in males, age forty to seventy. Grossly the lesions resemble soft smooth polyps. Microscopically, it consists of compact masses of neoplastic plasma cells, some of which are multinucleated, some quite anaplastic and some in mitoses. Some lesions remain localized, some metastasize to regional lymph nodes, some erode underlying bone and some eventuate as disseminated multiple myelomas.

The nuclei do not have the uniform cartwheel arrangement of chromatin; there is more cytoplasm which is less basophilic than the ordinary plasma cells, and cells are more cohesive. There is no Bence-Jones protein. The exact relationship between multiple myeloma and plasmacytoma is not clear. Many, however, apparently do eventuate as multiple myeloma, unfortumately even years after the primary plasmacytoma has been eradicated. The five-year survival rate of nasopharyngeal carcinoma is about 15 per cent.

THE NECK

In this region the malignant tumors of the cervical lymph nodes, salivary glands, larynx and thyroid will be discussed.

The most common malignant tumor of the neck is a carcinoma metastatic to a cervical lymph node from a primary site outside the neck. The metastases can be from a silent carcinoma of the mouth or pharynx.

Cervical Lymph Nodes. Asymmetric enlargement of the cervical lymph nodes in the adult is almost always malignant and usually is a result of metastases to a cervical lymph node.

Malignant lymphoma includes a number of variants: giant follicular lymphoma, lymphosarcoma including lymphatic leukemia, reticulum cell sarcoma, and Hodgkin's disease including the paragranuloma, granuloma and sarcoma.

The involvement of the cervical lymph nodes may be primary or part of a generalized lymphoma or leukemia. Lymphomatous tumors grow rapidly as a rule and are softer and bulkier than metastatic carcinoma; it is still not possible to distinguish between them clinically.

The giant follicular lymphoma has the best prognosis, while the reticulum cell and Hodgkin's sarcoma have the poorest. It should also be stressed that in time the lymphomas can alter their character; such transitions occur in perhaps 30 to 40 per cent of cases. The giant follicular lymphoma is the least stable and most notorious changer.

The common lymphoma involving the neck is the lymphosarcoma. It predominates in persons in the forty to sixty year age group, occurs equally in men and women, and has a five-year survival rate of about 50 per cent. The primary site in half of the cases of tumors in the neck is the tonsil.

Thyroid. Cancer of the thyroid accounts for up to 1 per cent of all human cancers and affects females mainly (65 per cent). The median age of involvement is fifty-two years, with a general range of from forty to sixty

years. Twenty per cent of cases occur in persons below twenty years of age and 6 or 7 per cent occur in young children.

Carcinoma is present in about 3 per cent of all thyroidectomies. Ninety to 95 per cent of carcinomas are said to occur in diseased thyroid, namely, thyroid with adenoma, adenomas or nodules. This view, I believe, is open to serious re-evaluation.

The predominant malignant tumor of the thyroid is the adenocarcinoma; rarely lymphosarcoma, fibrosarcoma, malignant teratoma and squamous cell carcinoma can arise in the thyroid.

The adenocarcinomas of the thyroid have been classified in many ways. The simplest is to divide them into three basic types: the papillary, including lateral aberrant carcinoma, which by far is the most common and least malignant; the follicular, including Hürthle cell carcinoma; and the undifferentiated carcinoma simplex which includes several variants, a small cell and giant cell carcinoma. It should be pointed out that most carcinomas are a mixture of types, with one component usually predominating. The prognosis is best with the papillary tumors, not so good with follicular and terrible with the undifferentiated simplex.

The criteria for malignancy of adenocarcinoma of the thyroid when atypia is not particularly marked, which is not infrequently the case, is invasion through the capsule, invasion of blood vessels and lymphatics, and metastases to regional lymph nodes or more distant structures.

Papillary carcinoma of the thyroid is particularly important because it occurs in young people as well as older people, can be detected early and has the possibility of a high survival rate if therapy is prompt and adequate. Sixty-five per cent are in females. Although this is the common carcinoma of the thyroid, it is mixed with a follicular component more often than it is pure. It should also be pointed out that disease of the thyroid generally is more common in females, as is carcinoma; however, a nodule is more likely to be malignant in a male than in a female.

Grossly, papillary carcinomas are variable in size, very often small, firm and gray, at times large and bulky, and often multicentric. Microscopically, there are numerous delicate branching vascular stalks of fibrous tissue or papillary infoldings covered by one or more layers of plump epithelial cells, generally with abundant cytoplasm. The cells may vary little in any characteristic, and mitoses may be few in number. The usual criteria of capsular invasion, blood vessel or lymphatic invasion or metastases need be applied to make the diagnosis. At times, however, there is a tendency for the epithelium to pile up, form large masses or sheets, invade the stalks and show sufficient atypia to establish the diagnosis. Some pathologists believe that virtually all papillary tumors of the thyroid are malignant. Small calcific psammoma bodies or spherules are at times present in the body of the papilla.

Spread is usually via the lymphatics to regional lymph nodes, but the tumor can spread locally and rarely invades blood vessels to metastasize to lung and bone. Lateral aberrant cancer of the thyroid is now established as a papillary carcinoma metastatic from a primary site in the homolateral lobe of the thyroid. Occult sclerosing carcinoma is another variant. These tumors can grow slowly and lie dormant for years. Survivals of fifteen to twenty-five years are common.

Follicular carcinomas are more malignant than papillary tumors. Mixtures of the two, however, are more common than are either as pure lesions. Grossly, the lesion presents as one or more unencapsulated gray-white firm masses or at times soft, dark red masses. Sometimes firm gray-white tumor tissue overgrows the thyroid, replaces it and extends through the capsule to the trachea, muscle, vessels of the neck and even skin. Microscopically, the pattern of the thyroid is reproduced. There may be well formed acini with colloid, acini without colloid, abortive suggestions of acini or merely solid masses of follicular or acinar epithelial cells. These neoplastic follicular cells may be uniform or can vary considerably in all characteristics, and usually have an abundance of cytoplasm. Mitoses are present and obvious but not numerous. Blood vessels as well as lymphatics are invaded early, and metastases are to lymph nodes, lungs and bones. Death usually occurs in three to five years. The follicular carcinoma with colloid-filled acini is the one that picks up the radioactive iodine. Hürthle cell carcinoma, with its large cells with abundant eosinophilic cytoplasm and small hyperchromatic nuclei, and non-cohesive cells, is a variant of follicular carcinoma.

Undifferentiated or carcinoma simplex is the

most malignant variant of carcinoma of the thyroid. It occurs at the oldest end of the age spectrum for cancer of the thyroid (sixty to eighty years). Grossly, these tumors present as large, bulky, invasive masses with evidence very often of involvement of blood vessels, necrosis due to infarction and invasion beyond the capsule. Microscopically, the picture varies from solid masses of small, round, rather uniform cells resembling lymphosarcoma to haphazard arrangements of large neoplastic and bizarre giant cells that vary considerably in size, shape and staining qualities. These are highly malignant, and death usually occurs in six months to a year.

The thyroid rarely is the site of lymphosarcoma, reticulum cell sarcoma and Hodgkin's disease.

Larynx. The larynx extends from the tip of the epiglottis to the inferior margin of the cricoid cartilage; therefore, carcinoma of the larynx includes the malignant epithelial tumors of the epiglottis, aryepiglottic folds, arytenoids, ventricular bands, ventricles, vocal cords, subglottic area and postcricoid region. Classically, laryngeal carcinoma is divided into two groups, intrinsic and extrinsic. The intrinsic lesions arise on the vocal cords, ventricles and subglottic region, and the extrinsic lesions arise on the upper surface of the ventricular bands and epiglottis or in the postcricoid region. Seventy per cent are intrinsic and 30 per cent are extrinsic.

Laryngeal cancer comprises about 20 to 40 per cent of human cancers, occurs in the middle and older age groups, and predominates in men (up to 98 per cent).

The predominant cancer of the larynx is the squamous cell carcinoma. It may be preceded in its development or be associated with either papilloma or leukoplakic keratosis, or in most cases have no antecedents. A good number of invasive carcinomas are associated with *in situ* or preinvasive carcinomas. The majority of laryngeal carcinomas arise on the anterior portion of one vocal cord. The second most common site is the subglottic area. Grossly, these tumors present early as a circumscribed or diffuse gray to pink thickening of the cord with either a smooth or granular surface. The fully developed tumors can be papillary or ulcerated and infiltrate underlying tissues. The elevated lesions are firm, gray, friable and bleed easily. The tumors vary from millimeters to 5 or 6 cm. in diameter and can destroy one or both cords. Some lesions begin as pearly gray, plaque-like areas which go on to ulcerate, fungate and spread centrifugally at times, widely infiltrating the perilaryngeal structures.

Microscopically, the great majority (95 per cent) of intrinsic carcinomas are well differentiated squamous cell carcinomas. These tumors tend to remain fairly well localized, extend slowly along the mucosa of the larynx, trachea, pre-epiglottic and perilaryngeal space, eventually to infiltrate the anterior wall of the larynx and to metastasize later to regional lymph nodes and even to distant viscera, lungs, thyroid, liver, kidney and other organs. Death from intrinsic carcinoma is usually a result of direct extension, ulceration with secondary infection and debilitation. Some, however, can have widespread metastases and produce pneumonia, lung abscesses and bronchiectasis.

The extrinsic carcinomas are generally undifferentiated squamous cell carcinomas that are aggressive, grow rapidly and metastasize early. Metastases are usually to deep-lying lymph nodes along the internal jugular veins. In general, the degree of anaplasia or undifferentiation of a carcinoma increases the further its site of origin is from the vocal cords.

The prognosis is worse with the extrinsic carcinoma; the five-year survival rate for intrinsic carcinoma is in the area of 45 per cent while that for extrinsic is only 10 per cent, overall for all types being 25 to 30 per cent. The cure rate for extrinsic carcinoma has been raised somewhat with bold surgery in some cases to 20 and even 25 per cent.

Rare tumors that also arise in the larynx are the transitional cell carcinomas, adenocarcinomas arising from salivary type glands or laryngeal mucous glands, a bronchial type of adenoma, lymphosarcoma and plasmacytoma.

A word should be said about the granular cell myoblastoma. It is benign, arises in the larynx and often is associated with marked epithelial hyperplasia which is unfortunately easily confused with early squamous cell carcinoma. (Fig. 8.)

Salivary Glands. The major salivary glands comprise the paired parotid submaxillary and sublingual glands. Tumors most frequently involve the parotid gland in 85 per cent of cases, the submaxillary glands in about 15 per cent of cases and the sublingual glands only very rarely. Malignancies of the salivary gland

can also arise from so-called minor salivary glands found in the mouth, particularly and most commonly from the palate. Up to 25 per cent of tumors of the parotid gland are malignant or at least locally malignant, while only 25 per cent of tumors of the submaxillary gland are benign. The malignant tumors of the salivary glands are the malignant mixed tumor, the adenocarcinoma of several types, the mucoepidermoid tumor and carcinoma, the epidermoid carcinoma and rarely seen clear-cell carcinoma, unclassifiable anaplastic malignant tumors, malignant lymphomas and metastatic tumors from regions as distant as the kidney. The ratio of benign to malignant tumors of the salivary glands is 3.5 : 2.

In my experience the malignant mixed tumor is uncommon, perhaps totaling under 5 per cent of mixed tumors. The high rate of recurrence of the benign mixed tumor is, in my opinion, the result of inadequate excision. This is due to the manner of growth of this tumor, i.e., its growth with bulbous bosses or projections out into the salivary gland which are very easily cut through. The uncommon outspokenly malignant mixed tumor predominates somewhat in women forty to sixty years of age. The tumor has the general features of a mixed tumor with glands, tubes and nests of cells lying in a mucoid cartilaginous stroma except that the epithelial cells instead of being uniform are variable in size, shape and staining quality. Many have nuclei with large nucleoli, there are numerous abnormal mitoses at times, densely cellular areas, areas of necrosis and at times evidence of invasion of nerve sheaths. The histologic diagnosis of this lesion can be quite difficult. This tumor can be of long duration but the prognosis is poor and it produces local and distant metastases.

The most common malignancy is the adenocarcinoma. The most common variant of adenocarcinoma is the cylindroma or adenoid cystic adenocarcinoma, other types being the papillary adenocarcinoma and simply adenocarcinoma.

The cylindromatous adenocarcinoma occurs not only in the parotid and submaxillary glands but also in the palate. A similar tumor occurs in the nasal cavity. Ten per cent of tumors of the parotid gland are cylindromas. They are usually unilateral and occur in persons within the age range of thirty to sixty-five years. Histologically it consists of islands, cords, clusters and strands of small, dark, relatively uniform cells with

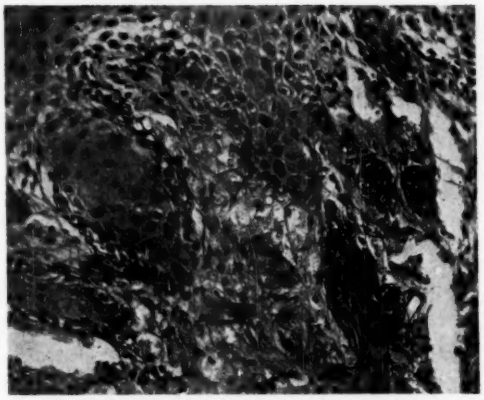

FIG. 8. Myoblastoma with pseudoepitheliomatous hyperplasia of covering epithelium.

relatively large, ovoid nuclei and sparse eosinophilic cytoplasm around central spaces either empty or filled with hyalin or mucoid material. Commonly the cells lie in large masses honeycombed with these spaces. The surrounding stroma is fibrous with areas of hyalinization and mucoid change. Mitoses are rare. Belying their relatively benign appearance, these tumors stubbornly recur, are locally destructive, invade perineural sheaths and in time spread to lymph nodes and to lungs. This is truly a malignant tumor and can kill the patient. The cylindroma is radioresistant.

Adenocarcinomas of the papillary gland are rare and microscopically consist of well defined papillary structures lined by mucin-secreting epithelial cells. Foci of hemorrhage and necrosis are common.

Adenocarcinoma microscopically presents a variety of patterns, generally small, obvious or abortive glands diffusely infiltrating a fibrous stroma in which may be hyaline or mucoid changes. The cells lining these glands are obviously neoplastic. These tumors are highly malignant, grow rapidly and metastasize early. They can be so undifferentiated as to resemble a sarcoma.

Mucoepidermoid tumors, 5 per cent of tumors of the salivary gland, are destructive tumors of the salivary gland presumably of ductal origin and composed of two components; a mucus-secreting glandular epithelium and a squamous cell or epidermoid epithelium. In addition there is an admixture of small intermediate basal type cells which are apparently

the stem cells from which the main components are derived. The relatively benign variants called mucoepidermoid tumors are persistently locally recurrent and invasive while the malignant variant, mucoepidermoid carcinoma is an outspoken cancer which recurs, invades, includes tumors of both low and high grade malignancy and is capable of metastasizing.

Microscopically there are admixtures of the two types of epithelial lining; mucus-filled cystic spaces and secondary reactions in the stroma to extruded mucin released from such ruptured cysts. The abundant stroma widely separates the epithelial components.

The outspoken malignant variants have little stroma, the tumor cells form large sheets and the epidermoid component usually predominates. The cysts lined by mucus-secreting columnar cells are small; single cells with mucin-filled cytoplasm are scattered in the stroma. There can be invasion of surrounding structures, perineural lymphatics and regional lymph nodes. The age range is from thirty to sixty-nine years and the sexes are affected almost equal. It is difficult to distinguish the relatively benign tumors from the outspoken malignant tumors. Rare, highly malignant tumors are the epidermoid carcinoma, lymphosarcoma and unclassifiable undifferentiated tumor.

SUMMARY

The head and neck, for this discussion, have been divided into three regions: the mouth, nose and neck. The predominant malignancy of the mouth region is the squamous cell carcinoma, well differentiated anteriorly toward the lips and poorly differentiated posteriorly; of the nasal region, the transitional cell carcinoma often with features of squamous cell carcinoma, of the neck: salivary glands, adenocarcinoma of the adenoid cystic variety; of the thyroid, adenocarcinoma of the papillary type; of the larynx, squamous cell carcinoma; and of the lymph nodes, metastatic carcinoma and lymphosarcoma.

Oral Cancer in Women

A STUDY OF THE INCREASING INCIDENCE

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"THE disease of our century is cancer." This statement dramatizes the importance of a major challenge to our professional abilities, and should stimulate our efforts to control this scourge. While we may not alleviate suffering from cancer as effectively as that caused by other diseases, and only too seldom do we achieve a cure, perhaps we can do more in the way of prevention. With this thought in mind we have been motivated to make this study of the incidence of oral cancer in women.

Clinical observation in recent years has strengthened the impression that cancer of the oral cavity in women is increasing in frequency. Two decades ago cancer of the mouth was, in our experience, an unusual finding in a female patient. Such a patient would be singled out as of special interest for demonstration and teaching purposes.

At the present time one may find at any given moment one or more examples in the wards or clinics of the Cook County Hospital and the Research and Educational Hospital. Last year, 1958, there was one period when five such patients were present on the Maxillofacial Service at the same time.

To substantiate this clinical impression, the records of each hospital were studied. A search was made through the history charts of patients admitted for treatment of cancer of the mouth for the periods 1943 to 1947 and 1953 to 1957. A comparison of these findings will be presented herein.

Other authors have noted a progressive increase in the ratio of women to men for this disease. One of the most thorough studies is that of Pack and LeFevre [2] in 1930. They analyzed their statistics according to the site of each variety of oral malignancy.

The ratio of females to males according to site of occurrence of the carcinoma was as follows: carcinoma of the lip, 1 to 16.2; of the floor of the mouth 1 to 18.8; of the buccal mucosa, 1 to 8.5; of the tongue, 1 to 1.6; of the tonsils, 1 to 9.8; of the esophagus, 1 to 4.1; of the stomach, 1 to 2.2; and of the intestines, colon and anus, 1 to 7, 1 to 1.3 and 1 to 1.5. It is of interest that the ratio of frequency, according to sex, in the alimentary tract (and its accessory organs) became progressively less as the location changed from oral cavity toward anal orifice.

Carcinoma of the tongue was often found in the early years of life, and then occurred as frequently in females as in males. This is explained on the basis of congenital embryonal cell rests or inclusions and is in line with our own experience [3].

In explanation of the marked preponderance of oral cancer in males, Pack and LeFevre [2] stated that the "overwhelming predominance of intraoral sources of chronic irritation, infection and inhalation of acrid pipe smoke in males is the only tangible explanation available."

In 1930 Lane-Claypon reported a 9.8 per cent occurrence in females. Wookey, Ash, Welsh and Mustard [5] stated that in their experience, from 1929 to 1945, oral cancer was primarily a disease of the male, being ten times more frequent in men than in women. Ninety-eight per cent of cases of cancer of the lip were in males; in other oral carcinoma the percentage was 80. They mention oral sepsis and dental neglect as often being a marked feature in the patients they saw. The habit of chewing tobacco was linked to carcinoma of the buccal mucosa but smoking was not mentioned. It would seem that the latter vice was not a female habit at

TABLE 1
DIVERGING TRENDS ACCORDING TO SEX
(AFTER RUSSELL)

Sex	No. of Cases* (1935–1939)	No. of Cases† (1945–1949)	Change (%)
Females....	119	209	+75
Males.....	1077	777	−27

* Ratio 1:9.
† Ratio 1:3.71.

that earlier date. In 1932 Fraser found 12.5 per cent (one in eight) in women, [6], while in 1940 Martin, Munster and Sugarbaker reported 13 per cent in females out of a total of 556 patients [7].

In 1937 Morrow [8] reported on ninety-seven patients with cancer of the tongue. The frequency in women was one to seven or 14 per cent. A history of the use of tobacco was obtained in seventy-six patients, 46 per cent used it excessively and 36 per cent moderately. Of sixty-five patients, 63 per cent had "bad," "poor" or "irritating" dental conditions. Morrow emphasized that the interval from onset to the time the patient seeks relief is usually much too long for one to expect good results from treatment, even though the mouth is most accessible to inspection, and warning from observable changes is present for a considerable time before actual malignancy develops. In 1945 Laurence and Brazina [9] reported on 145 cases of oral carcinoma, 12 per cent among women, and in 1949 Perry and Cameron [10] cited 10.5 per cent in women, of ninety-five patients. In 1952 Lyall and Schetlin [11] reported on seventy-six unselected patients with cancer of the tongue. Of these twenty-two were women and fifty-four men, a ratio of about 1 to 2.5 or 42 per cent. In 1955, Russell [12] made an interesting study in England and pointed out that diverging morbidity trends according to sex were developing. In women there was an increasing incidence of cancer of the mouth, and in men there was a decreasing incidence. Thus, in females, from 1935 to 1939, 119 cases were found. This increased to 209 cases in the period from 1945 to 1949. In males, however, 1,077 cases were seen in the 1935 to 1939 period, and only 777 in 1945 to 1949. This represents an increase of 56.3 per cent in female patients over a decade of time, compared with a decrease of 27.48 per cent in male patients. The proportion of female patients to total cases was 9.95 per cent in the first period of time but in the latter period had shown a marked increase to 21.19 per cent. (Table 1.)

That local irritation of a persistent and long-continued character influences the development of oral cancer was a frequent observation in Russell's series. That the habitual use of tobacco constituted such a deleterious influence was increasingly evident. A summary of Russell's data indicates the following pertinent findings regarding the changes in morbidity rates for each sex over a decade of time: Carcinoma of the tongue decreased 38 per cent in males and increased 60 per cent in females. Carcinoma of the main oral cavity decreased 43 per cent in males and increased 33 per cent in females. Carcinoma of the faucial region decreased 50 per cent in males, and increased 100 per cent in females.

However, Russell noted that the results of treatment were better in female patients as judged by mortality, recurrences and metastases of the secondary lymph nodes. He listed estrogenic factors, a lesser incidence of syphilis and better standards of oral hygiene in women as favorable influences.

Hoover and King [14] stated of the typical victim of oral cancer: "These individuals are heavy smokers." They were also of the opinion that any chronic irritative and inflammatory lesion within the mouth is a definite etiologic factor whether due to dental sepsis, tobacco, avitaminosis or syphilis. They cited Kinoshita's work [15] which suggested that an interaction of several factors may be necessary to produce neoplasm. Smoking was found to be an important factor in the development of cancer of the oral cavity in the experience of Wynder, Bross and Feldman [16]. Twenty-one per cent in their series of 659 cases occurred in women. Twenty-nine per cent of patients with cancer were excessive smokers compared with 17 per cent of a control group.

In men, smoking one package of cigarettes per day increased the risk of developing cancer of the mouth threefold over that for non-smokers or minimal smokers. Only three per cent of 543 men with oral cancer had never smoked, compared with 10 per cent who were non-smokers in the control group. This finding was also valid for women. The relative risks of smoking were similar for women as for men. In

women with cancer of the mouth, there were three times as many chain smokers as in the controls. Of the 116 female patients, 14 per cent smoked one package or more per day.

Consumption of tobacco and alcohol was considered by Hoover and King [*14*] to be major extrinsic factors influencing the development of oral cancer. An increase in incidence of cancer of the mouth was noted among women, the result of the fact that women never having smoked cigars and pipes to any extent have recently begun to smoke cigarettes. An apparent paradox was found in that cancer of the oral cavity was not increasing in men, but that a moderate increase had been noted among women. Consumption of cigarettes was found to have increased from 1.9 pounds per person in 1920 to 10.5 pounds per person in 1953. These authors were of the opinion that four of five cases of oral cancer are preventable.

In our study, the records of the Research and Educational Hospitals of the University of Illinois showed for the period 1944 to 1948 an incidence of oral cancer of 11.11 per cent in women in the ratio of 1 to 10. For the period 1954 to 1958 this had increased to 19.83 per cent in the ratio of 1 to 4.71. A Cancer Clinic was established during the latter period which probably accounts for the larger number of patients.

From the records of the Cook County Hospital, it was found that for a five-year period, 1943 to 1947 inclusive, there was a total of 302 patients. Of these forty were women and 262 were men, in a ratio of 1 to 6.55. The percentage of female patients was 13.23 per cent of the total. (Table II.) In the second period, 1953 to 1957, at the Cook County Hospital there were forty-six women and 210 men, a total of 256 patients. The ratio of women to men was 1 to 4.56 and the percentage of female patients was 18 per cent of the total. Thus there was a decrease of fifty-two male patients and an increase of six female patients. This change in the morbidity according to sex is in agreement with that reported by Russell [*12*].

While statistics from many sources vary, the indicated trend is constant. The difference in occurrence varied according to the origin of the material. Our group at the Research and Educational Hospitals is probably of a higher social and economic level than the group studied at the Cook County Hospital. The latter group of patients did not present for treatment until

TABLE II
ORAL CANCER AT COOK COUNTY HOSPITAL

Sex	No. of Cases* (1943–1947)	No. of Cases† (1953–1957)	Change (%)
Females ...	40	46	+15
Males.....	262	210	−19

* Ratio 1:6.55.
† Ratio 1:4.56.

there was a more advanced pathologic involvement. They were less heedful of advice and less cooperative in carrying out orders. Response to treatment was poorer. Recurrences, morbidity and mortality were considerably higher.

While considerable thought and work have been given to elucidating the relationship of the habit of smoking to cancer of the lung, very little study has been directed to a similar possible relationship with oral cancer. In the earlier records of the two hospitals we found a consistent paucity of facts relating to dental conditions and oral hygiene, states of trauma and irritation, infections, syphilis, leukoplakia and associated sites of cancer. The case histories which we examined were notably deficient in recording whether tobacco was used at all; and if it was mentioned, the quantity, frequency and type were seldom detailed, nor was it stated over how long a period the patient was exposed to this factor. It is noteworthy, however, to find that since about 1955, the case histories in the files of the Cook County Hospital show a marked improvement regarding this aspect. Evidently the interns and residents are now better alerted to the importance of habits as a causative influence in disease of the oral area.

We are of the opinion that the length of time (duration) of exposure may be of considerable importance. We, therefore, always question the patient regarding the age at which the habit of smoking was started, and compare it with the age at which symptoms of the tumor commenced, to arrive at the duration of exposure (as well as the type and quantity). In most of our patients the exposure was continuous for ten to twenty years. It seemed that a "day of reckoning" could be expected after twenty years. This is also the opinion of Russell [*12*] who dogmatically stated: "It is conventional to regard the incubation period

for cancer as twenty years." Therefore we may expect to encounter more cases in the near future because a large segment of our female population has now had this lengthy exposure. Wynder, Bross and Feldman [*16*] studied the etiologic relationship of the habit of smoking to oral cancer but did not evaluate the duration of such exposure.

The idea has been advanced that tissues of the female may be more resistant to neoplastic degeneration until a "trigger" factor, e.g., smoking, upsets the retarding influence. However, this idea that tissues of the female may have a relative immunity to cancer is not borne out by statistics relative to cancer of the lung. The total incidence of carcinoma of all kinds in women has declined mainly because cancer of the pelvic organs has decreased, but when women have had the same exposure to cigarette smoking as men, the occurrence of cancer of the respiratory organs is just as frequent [*18*].

The thought that hepatic cirrhosis may be linked to oral cancer has been mentioned, but is entertained by only a few observers. Anemia, avitaminosis and menopausal changes have also been advanced as contributing influences of cancer in women. "In men, local aggravation is a relevant factor in susceptibility to the disease, but in women a systemic influence (such as microcytic anemia) is a factor." This statement by Patterson, Tod and Russell [*19*] in 1946 related especially to oral cancer.

The not infrequent finding of multicentric tumors in the mouths of patients who persistently exhibit the baneful influences of excessive smoking, poor oral hygiene, chronic infection and irritation strengthens the observation that "in a large majority of cases, cancer is a disease resulting from disease; it rarely occurs in a previously healthy tissue" [*20*]. The factors producing an environment favorable for the development of oral cancer are poor oral hygiene, chronic uncontrolled syphilis and, of course, advancing age. The frequent association of cancer of the tongue and syphilitic glossitis has long been recognized. Women are naturally somewhat fastidious in their personal habits. Their oral hygiene is usually better than that seen in male patients. Women are impelled more by esthetic and cosmetic rather than health motives. As Pack and LeFevre [*2*] mentioned, women patients exhibited "better oral hygiene, teeth cleaner and in better repair, less pyorrhea, less leukoplakia, less syphilis, majority still have less irritation from tobacco; they have fewer intraoral cancers." That statement was made in 1930. It would seem that the intervening twenty-nine years have witnessed an unfavorable revision of this opinion. It would now appear that this hypothesis of local irritation applies increasingly to women.

CASE REPORTS

CASE 1. A forty-one year old white woman was admitted to the Research and Educational Hospital in December 1958, her seventh hospitalization for resection of metastatic nodes in the right side of the neck.

Since December 16, 1957 she had had multiple surgical procedures for multicentric malignancies of the oral cavity. At that date she presented with a history of having smoked more than three packs of cigarettes daily for all of her adult life. From about 1952 a whitish thickening of the lining of the oral cavity had been noticed. Since 1954 there had been increasing roughness which spread to practically all of the oral mucous membrane. In November 1957 she was told by her dentist to apply to the University of Illinois for treatment, but she did not appear until December 1, 1957.

Generalized leukoplakia was found involving the oral mucosa and extending into the hypopharynx, the base of the epiglottis and the nasopharynx. Biopsy of the roughest area was performed, and revealed epidermoid carcinoma. Excision and electrocoagulation of the retromolar area and alveolar ridge were accomplished. In spite of warnings she continued smoking at least two packages of cigarettes daily.

In January 1958, a repeat biopsy disclosed a new carcinomatous lesion in the left posterior aspect of the mandibular ridge. Partial excision of the mucous membrane was performed, followed on February 28 by partial mandibulectomy on the left side and dissection of the upper portion of the left side of the neck. The pathology report showed epidermoid carcinoma of the left alveolar ridge with metastases to the regional lymph nodes.

On October 6, 1958 the patient returned to the hospital, presenting a fungating lesion of the left side of the hard palate. Maxillary resection was performed, removing the greater part of the hard palate (approximately three-fifths) extending to the floor of the nose.

The patient was admitted for the seventh time on December 17, 1958. Enlarged lymph nodes were palpable on the right (contralateral) side of the neck. Complete dissection of the right side of the neck was performed on December 18. Postoperative hematoma required ligation of a bleeding vessel and tracheotomy.

In March 1959, the patient again presented with recurrent neoplastic growth at the site of the previous palatal resection. Leukoplakic changes included the vocal cords. She stated at this time that smoking had been discontinued. However, because of the patient's failure to stop smoking following previous warnings, her statement that the habit was discontinued is doubted.

CASE II. Mrs. A. K., fifty years of age, was seen at the Cook County Hospital on March 16, 1959. She gave a history of smoking one to two packages of cigarettes per day since she had been sixteen years of age.

She had noticed episodes of irritation and soreness of the mouth and throat during the previous year. Seeking relief and influenced by dramatic advertising she "switched brands" to various filter, cooling, less-tar, and/or better tasting types without noticeable benefit.

When examined, the oral and pharyngeal mucosa was hyperemic with several areas of leukoplakia on the alveolar and buccal mucosa, and an elevated, ulcerated lesion in the left retromolar and left tonsillar regions. This tumor appeared to involve the upper pole of the left tonsil and extended across the mid-line of the soft palate. There was inflammation and infection of a large cervical lymph node on the left side.

Because of the extensive palatal involvement, radiation therapy was chosen as the better modality of treatment. After several treatments, the inflammation of the cervical lymph node regressed considerably. The primary oral lesion was also somewhat reduced in size and the patient was more comfortable. The leukoplakic changes remained unchanged.

In spite of repeated, explicit warnings, this patient continued to smoke. When last seen the original oral lesion was again progressively increasing in size.

COMMENTS

If progress is to be made in preventing oral cancer, greater attention should be directed to discovering and removing possible etiologic influences, such as long-continued exposure to irritants, e.g., tobacco.

Studies of the histories of patients who were treated for oral carcinoma reveals that inadequate attention has been directed to eliciting possible causative exposures. A good case history should describe under the heading of habits: (1) the type of irritant used, (2) the quantity, and (3) especially the length of time over which exposure was continued.

Meticulous examination of oral structures should be an essential part of every history.

Patients who exhibit so-called precancerous changes, as well as those having frank oral cancer, must be educated to stop the further use of tobacco or other irritants in order to prevent a renewal of the disease at the original or other sites. This is truly practicing prevention of cancer.

The surgeon is remiss in his management if he does not attempt to eliminate all predisposing and contributing factors. To remove one cancer and leave the remainder of the mouth in fertile condition for further mischief is shortsighted therapy and an invitation to recurrence.

Often it may require much effort and time to re-educate the patient. One must be positive and direct, and at times even blunt, in order to secure the patient's cooperation. One should not hesitate to instill a measure of cancerophobia, if necessary. The patient should be plainly told that cancer is a killer, and that smoking must be stopped immediately, permanently and completely; not wait until tomorrow, not for just a week or a month to see if the mouth clears up and not cut down to half a package or change to a filter brand.

SUMMARY

1. An increase in the incidence of oral cancer in women is demonstrated by a study of the records of the Cook County Hospital and the Research and Educational Hospitals of the University of Illinois.

2. Other investigators have found a similar trend.

3. This increased incidence in women is associated with an increasing use of tobacco by women and suggests a causal relationship.

4. A long duration of exposure to the use of tobacco prior to onset of symptoms is a consistent finding.

5. If a degree of prevention of oral cancer is to be achieved, physicians must advocate a program which will: (1) educate their patients to avoid harmful habits such as smoking, to seek early advice and aid if any abnormality is suspected and to practice self-examination of the oral cavity (similar to the self-examination of the breasts which is taught to women); and (2) help to discover and remove or correct noxious influences such as neglected oral hygiene, chronic dental infection and inflammation, mechanical, thermal, actinic and chemical irritants, and early lesions such as leukoplakia and benign growths.

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Present Medical-Legal Considerations—A Summary

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IN preparing this paper, I was reminded of Lewis Carrol's "Alice in Wonderland," and specifically of the walrus. When I contemplate the appearance of the uninitiated surgeon on the witness stand and further think of the opening comments of the opposing lawyer, I wonder if the physician hears something like this: "The time has come," the lawyer is saying, "to speak of many things. Of duty, of dereliction, of negligence and of obscure pains." At this time I am sure the testifying physician may find himself in a looking-glass world that is as unreal to him as was Alice's to her. This is the world of forensic medicine! (Fig. 1.)

Forensic medicine, or medical jurisprudence, has many definitions, and the field may be divided into four divisions. Each division represents a separate specialty in itself: personal injury, professional liability, medical legislation and the field of the medical examiner.

I. PERSONAL INJURY

Surgeons who are interested in the anatomical areas of the head and neck must be aware of their vulnerability in litigation. Usually, when a physician considers litigation, he considers malpractice as the paramount problem. While a malpractice suit is one of the most serious problems a surgeon may face, suits of this type are not the most frequent in the conduct of litigation involving the physician. As a matter of fact, they represent only a small portion of the total number of cases. The division of litigation for personal injury represents by far the most important aspect of medical jurisprudence. In the last ten years, average jury awards in personal injury suits have risen astronomically. (Fig. 2.)

The physician usually enters court as an expert witness for either the defense or the injured party. The plaintiff in suits of this nature is no longer suing the responsible party but his insurance carrier. (Fig. 3.)

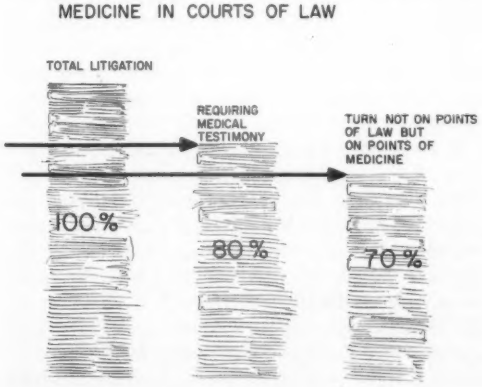

FIG. 1.

II. PROFESSIONAL LIABILITY AND MALPRACTICE

A review of malpractice cases in Los Angeles County in 1958 revealed the following rather startling statistics: Of the 9,000 physicians registered in Los Angeles County, one of

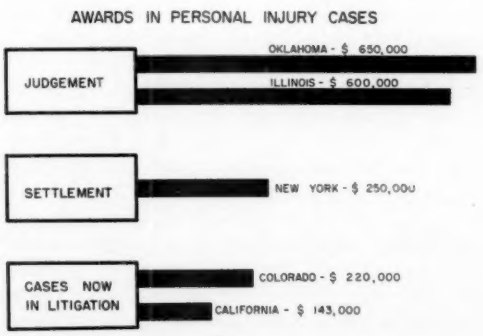

FIG. 2.

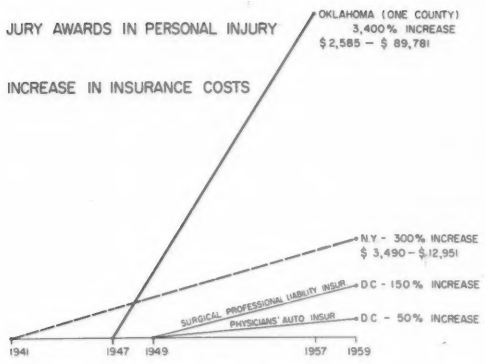

FIG. 3.

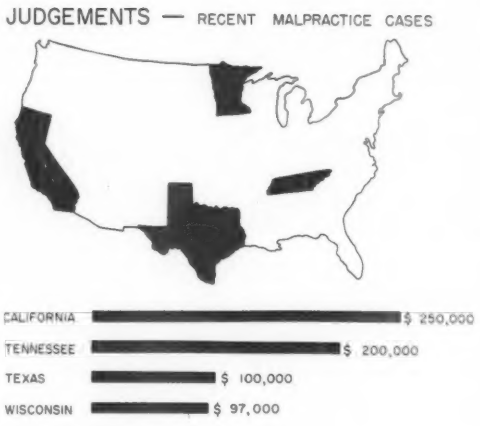

FIG. 4.

fifteen was currently being sued on charges of malpractice at the time this review was prepared. Across the continent in New York, a survey that covered the years since 1950 revealed that one of every thirty-five doctors in the New York State Medical Society Group Insurance Plan had been sued for malpractice. The classic problem of the plaintiff's attorney in lawsuits of this type has been in obtaining expert witnesses in the pursuit of his case. The physician, at the same time, has believed that this type of case opens the door for litigation, in many instances, concerning justified failures in therapy. I repeat, malpractice cases, in terms of numbers, are relatively few in most jurisdictions. Most of these cases are settled out of court and never come to trial. (Fig. 4.)

III. MEDICAL LEGISLATION

Each day laws are written on the local, state and national level dealing with the problems of health. They may represent sound legislation proposed by physicians and written by lawyers, or this legislation may equally represent unsound laws proposed or written by either. A good health law, badly written, will fail just as surely as an inherently poor one. If we discount the issues and the arguments involved in such controversial legislation as the proposed H.R. 9467 (the Forand Bill), one may readily appreciate that every taxpayer in the country is vitally interested in medical legislation. So, of course, is the physician because of the implications of state medicine versus free choice of medical care. (Fig. 5.)

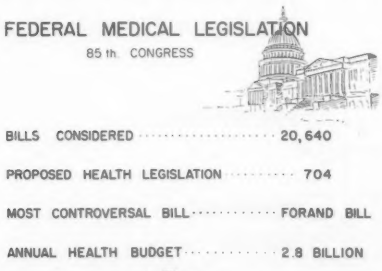
FEDERAL MEDICAL LEGISLATION
85 th CONGRESS
BILLS CONSIDERED 20,640
PROPOSED HEALTH LEGISLATION 704
MOST CONTROVERSAL BILL ..... FORAND BILL
ANNUAL HEALTH BUDGET ..... 2.8 BILLION

FIG. 5.

IV. THE MEDICAL EXAMINER

In most jurisdictions there exists either a coroner or medical examiner system. The work of these officers exists in medicine as it relates to the law regarding unexplained or violent death. The medical examiner's duties are much broader than those of the coroner in that his office often furnishes the scientific evidence required for the successful conduct of a trial. This may range from blood alcohol studies in traffic violators to ballistics information required in murder cases.

In my own jurisdiction in Virginia we have one of the best organized departments of this type in the country. At the time of writing, the director, Dr. Geoffrey Mann, has the major responsibility for the medical evidence in the Jackson family murder case which is currently receiving national attention. I shall refer to Dr. Mann and his work later in this paper. The general impression among physicians is that discounting litigation for malpractice, the entire field of forensic medicine falls somewhere

in the area of criminology. This is, of course, a most colorful and dramatic area. However, this represents, again, only one of the smaller divisions of the specialty.

HISTORY

To the surprise of most physicians and attorneys, forensic medicine is not in any sense a new field of endeavor. Some 3,000 years before the birth of Christ, this was a highly developed form of jurisprudence in the Nile valley. At this time the chief adviser to the king of Egypt was a physician and jurist. If one studies the records of Greece, Rome, the Germanic states, England and France, one finds that forensic medicine played an important role in the conduct of national affairs. Historians have commented that as these civilizations reached their apex, the importance of forensic medicine also reached its height.

We, in this country, made an early start in this field when Dr. J. S. Stringham was appointed professor of jurisprudence in New York in 1813. Since that time this specialty has diminished in recognition and was not revived actively until the past decade.

THE SURGEON AND THE ATTORNEY

Although the physician may not approve of the Anglo-Saxon concept of the adversary system as a technic for discovering truth in a court of law, he must bring himself to learn as much as possible about the basic rules of the conduct of a trial in an American court. There exists a hard core of truth that the physician must accept in preparing himself for entry into litigation either as a defendant or as a witness.

1. The physician is obligated to understand in the beginning that his testimony may be questioned and scrutinized minutely. It is wise to assume that in talking to the lawyer who cross examines him, he is talking not to an uninitiated layman but to an educated man who has made an intensive study of the subject of the cross examination. It must be assumed that the lawyer has a medical library and that he has used it in the preparation of his case.

2. My first admonition to the surgeon then is to do his homework prior to entering the courtroom. He must review the anatomy of the areas of the body which are the subject of the litigation. He must also review the physiology and the recent literature pertinent to this subject.

3. The intelligent trial lawyer obtains the hospital record of the patient involved as an indispensable aid in the preparation of his case.

4. The physician's personal records of the case may be brought into court by subpoena and are most pertinent to the subject of the trial. These should be adequately dated and in enough detail to answer any question concerning the patient's diagnosis, illness, injury or progress following surgery.

5. Lawyers throughout this country have spent untold sums of money in the past ten years traveling to medical centers for seminars on injury, disease and trauma.

6. Generally, some obvious points bear repeating. All tissue removed from the human body for any reason must be forwarded to a pathology laboratory and the report entered in the record. A consent for any operation is an absolute "must." The cases of lawsuits against surgeons are legion involving the unauthorized removal of tissue from the body. One should never remove any lesion from any portion of the body without the patient's specific consent. One should never operate for a malignancy without a documented pathologic report involving a previous biopsy or frozen section.

As evidence of lack of preparation for medical cases I quote statements from a sample study made recently of cases presented to the Supreme Court of New York. Twenty-five per cent of the cases sampled evidenced errors in reading x-rays films involved in the litigation, and 25 per cent evidenced inadequate tests for proper diagnosis. It is extremely important for each doctor to follow a well defined pattern in his examinations, diagnoses and operative procedures.

ATTEMPTS AT SOLUTION

One's view of the medical-legal problem depends upon his locality. In some states there is practically no conflict between law and medicine. There tends to be less conflict in small communities where the persons in both professions know each other personally. However, in some metropolitan areas where litigation is high, there appears to be little dissension. For years, the courts in the District of Columbia have reflected conflict among the bench, the bar and the medical witness. This has centered around the legal concept of insanity versus the medical concept of mental disease, one being a legal definition and the other a medical

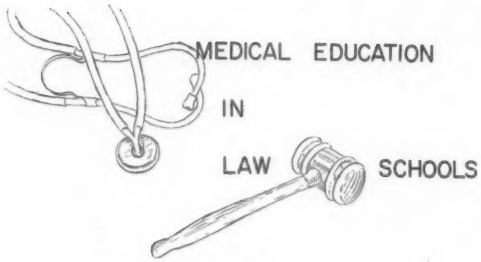
MEDICAL EDUCATION
IN
LAW SCHOOLS
ACCREDITED SCHOOLS 127
COURSES TAUGHT IN LEGAL MEDICINE 31
SCHOOLS WITH THESE COURSES 27
DEPARTMENTS WITH PHYSICIANS HOLDING DEGREE IN LAW 4

FIG. 6.

diagnosis. Our local problem, then, has arisen in the field of forensic psychiatry, a separate specialty in itself. In the recent past the office of the District Attorney sends its members to attend regular seminars in psychiatry conducted by the staff of a large federal hospital. A verteran observer of the courts in the District of Columbia has noted that recently the physicians who testify regularly are having less difficulty because of their better understanding of procedure and cross examination.

On the local level, in cities such as Cincinnati, Ohio, where the dissension between the two professions was great, the local medical society and bar association have adopted a code referred to as "standards of practice governing lawyers and doctors in Cincinnati." Generally, these codes contain provisions on conferences between physicians and attorneys, conduct of physicians as witnesses, the compensation of expert witnesses, and the arrangements for a physician to testify in advance of other witnesses. Some twenty-five other cities have since followed Cincinnati in accepting a code of this type.

On the state level, the state of New York became concerned over the conflicting testimony of medical experts. It was noted that the testimony of the facile, polished, "professional" medical witness had more effect on the lay jury than did the testimony of the better qualified, less adept expert. New York County has adopted the so-called "New York Plan." This involves the appointment by the court of an expert who holds the respect of the entire medical community. The "Baltimore Plan" is virtually the same with the exception of the fact that the testifying expert is paid by the litigants rather than by the court.

On the national level, the House of Delegates of the American Medical Association adopted in June 1958 a national "interprofessional code for physicians and attorneys." This same code was adopted by the House of Delegates of the American Bar Association the following August. Approximately five years ago the American Medical Association began to hold seminars on legal medicine in the major cities of the United States. These seminars are conducted by both attorneys and physicians. We recently had one in the District of Columbia, and they are well worth attending. The American Medical Association is also producing a series of worth while films underwritten by the William S. Merrell Drug Co.

SOLUTION TO THE PROBLEM

It is my sincere belief that we will never solve the problems of medical litigation by approaching them on the level of the graduate practitioner in law or medicine. The place to begin is with the undergraduate student. There are questions of philosophy which are basic, namely, the adversary system of approaching the truth versus the objective-scientific approach. There are troublesome problems of vocabulary, and there are also problems of protocol and the technic of trial procedure. The schools of law have been slow to recognize the need for instruction in medical topics. However, unfortunately, the schools of medicine have been slower yet. (Fig. 6.)

We in medicine continue to instruct our students in some of the more obscure phases of medicine rather than in these urgent problems of everyday practice. It is no surprise then that a physician may find himself totally uninformed as to his rights or duties in a court of law. The personal embarrassment and loss of professional prestige which follow a discredited medical witness is, of course, important to that person. However, this unfortunate set of circumstances presents a minor problem when balanced against the effect of this testimony upon the conduct of the trial in the future of the litigants. A number of years ago that irascible Irishman, George Bernard Shaw, stated that "all professions are conspiracies against the laity." I am sure that the injured plaintiff, or defendant,

who loses his case because of inadequate or misinterpreted medical testimony will readily agree with Mr. Shaw.

I believe that every school of medicine in this country should institute a course in forensic medicine. This course should be taught by a combined faculty of the best physicians and attorneys available to the institution. This course should be required and not presented as an elective.

My class in medical school studied in minute detail the life cycle of the anopheles mosquito and the tsetse fly. I daresay that of the graduates in the past two decades, less than 1 per cent have taken up practice in tropical countries. Yet, if any of these graduates were practicing medicine in Los Angeles at the time of the aforementioned survey, they might well be one of the fifteen physicians currently being litigated against. Not only would their worldly goods and reputation be at stake, but also in a broad sense the stature of the profession at large would be jeopardized. Obviously, the chances are even greater for a physician entering the courtroom as an expert witness, not once but many times during his career.

I am not suggesting that physicians should become lawyers or lawyers physicians. I am suggesting, however, that we, as physicians, begin to understand enough law to acquit ourselves adequately of our responsibilities in court. I further believe that we must gain enough forensic skill to withstand the pressures of cross examination. These abilities require thoughtful preparation. At present, a physician's introduction to the intricacies of the law is often the traumatic one of a participant in a lawsuit. It is my belief that this introduction must be in the classroom rather than in the courtroom.

Some 300 years ago John Milton defined a complete education as "That which fits a man to perform justly, skillfully and magnanimously all the offices both public and private . . ."

Elective Tracheostomy in Infants and Children

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THE problems associated with both emergency and elective tracheostomy in infants and children have been thoroughly discussed in the literature. Indeed, the justifiable publicity given to the high statistical morbidity and mortality rates with this procedure in infants has profoundly influenced the surgeon in his decision to act promptly during the desirable period of electivity. Too often, hesitancy during this golden period has resulted in later progressive and total obstruction to the airway, necessitating emergency tracheostomy with its still greater danger. Unquestionably, this procedure performed hurriedly at the bedside, often without the proper equipment and without benefit of an anesthetist, can be devastating.

Our investigation into the possible reasons for the high mortality and morbidity rates have revealed several outstanding facts.

Certain fundamental differences exist as one descends the scale from adults to children and finally to infants.

Although the indications for tracheostomy remain unchanged in all groups, the margin of safety is reduced as the infants are approached. Thus, the period of election is narrower. The small size of the infant airway and the high metabolic requirements are the main factors in this progressively more difficult situation. In addition, infants handle their pharyngeal and tracheobronchial secretions poorly and often choke, gag and even aspirate during feedings.

It has been clearly demonstrated that there is a fundamental etiological difference between respiratory obstruction in infants and older children. Bigler et al. [8] pointed out that in 51.6 per cent of sixty-two infants less than one year of age who underwent tracheostomy there was a congenital anomaly or neoplasm involving the larynx or trachea. In older children 90 per cent of the tracheostomies involved inflammatory disease.

From the technical aspect certain significant points are apparent:

1. The standard 90 degree Jackson tube universally utilized is excessive in length for the infant trachea, and can cause obstruction in the majority of instances. The obstruction can be immediate or result subsequently by the formation of granulation tissue at the carina or by the inspissation of secretions at the carina. In addition, a lengthy tube can readily slip into the right main bronchus and become occlusive.

2. Surgeons are often unaware of the precise anatomy in the region and are unable to recognize the aberrant anatomical structures during the performance of the tracheostomy.

3. The instruments are frequently too gross and the set-ups are incomplete to perform this delicate procedure in infants.

4. The lack of knowledge of tracheostomy aftercare on the part of the nursing personnel is often compounded by an attitude of indifference, and can result in serious complications.

5. Hospitals often fail to provide adequate equipment in the way of suction apparatus and tubing, and adequate instruments for postoperative care.

This paper is concerned with the causes and the measures necessary to correct the technical aspects of this distressing situation. Elective tracheostomy should be and can be a truly lifesaving procedure, providing there is proper timing and technic and effective postoperative care.

ANATOMY

The trachea in children varies in length from 4 cm. in a newborn infant to 5.7 cm. in an eight year old child. Table 1 shows the relationship of the size and diameter of the trachea in infants and children.

The trachea consists of a cervical segment and a thoracic segment, and terminates at the carina into a right and left bronchus. The right bronchus projects at approximately a 30 to 45 degree angle from the vertical trachea, whereas the left bronchus projects at a 50 to 70 degree angle from the trachea. Obstruction to the right bronchus is conceivably more prevalent due to this positional difference. The trachea is thin, rubbery and easily displaced. It is readily palpable in its upper half where it is covered only by skin, cervical fascia and the sternohyoid and the sternothyroid muscles. The thyroid isthmus crosses the trachea between the third and fourth rings. Below the isthmus, the trachea deepens and can be located by the depression between the converging sternocleidomastoid muscles above the sternal notch.

It is wise to keep in mind the following anatomical points:

1. The descending inferior thyroid veins course alongside the trachea just lateral to the midline. Injuring these veins may cause excessive bleeding.

2. Manipulation in the lateral direction may result in unilateral or bilateral pneumothorax if there should be a high pleural reflexion into the neck.

3. In the same manner, one may be confused by the innominate artery on the right side. The trachea must be palpated before incising it so as to make certain it is not pulsating.

4. The opening of cervical fascial spaces which surround the trachea, by undue manipulation, can result in an escape of air inferiorly into the posterior mediastinum, possibly causing a bilateral pneumothorax or a mediastinal tamponade.

5. If the thyroid isthmus completely conceals the trachea, it must be retracted or incised.

TABLE 1

ANATOMICAL RELATIONSHIPS OF THE SIZE AND DIAMETER OF THE TRACHEA IN INFANTS AND CHILDREN

Age	Length (cm.)	Sagittal Diameter (mm.)	Frontal Diameter (mm.)
0–1 mo.	3.8	3.6	5.0
1–3 mo.	4.0	4.6	6.1
3–6 mo.	4.2	5.0	5.8
6–12 mo.	4.3	5.6	6.2
1–2 yr.	4.5	6.5	7.6
2–3 yr.	5.0	7.0	8.8
3–4 yr.	5.3	8.3	9.4
4–6 yr.	5.4	8.0	9.2
6–8 yr.	5.7	9.2	10.0
10–12 yr.	6.3	9.7	11.3

TRACHEOSTOMY TUBES AND INSTRUMENTS

Tracheostomy tubes have remained unaltered in shape and size for the past seventy-five years. Practically all manufacturers now make sterling silver tubes with a full curve of 90 degrees. Although a cane-shaped tube is available, it is rarely found in most operating rooms as its shape prevents the use of an inner tube. For the most part, the tubes are constructed very long to accommodate all types of obstructive conditions without any regard to the size of the trachea. It becomes quite apparent that the average length of present day tubes has been designed for an adult, and then scaled down to be utilized for the child. The length of the trachea in children has received little consideration. Practically all operating rooms are equipped with these lengthy tracheostomy tubes. The surgeon will inevitably receive one of these poorly fitting tubes which, by its length, may impinge on the carina causing obstruction, unless he personally provides his own substitute.

Recent examination of various tracheostomy tubes taken at random from the operating rooms and supply rooms of several hospitals has shown that all the tubes made by various manufacturers are labeled as the improved Jackson type with a full curve of 90 degrees. It is interesting to note that the manufacturers' size range of tubes for use in the newborn infant to the twelve year old child are indicat ' from Nos. 0 to 4, the former measuring 6.5 cm. in length, while the latter measures 7 cm. in length; yet the entire length of the trachea in the newborn is only 4 cm., and 6.5 cm. in the twelve year old. Although the standard 90 degree curve of the present tube is awkward and inadequate in certain instances in the infant

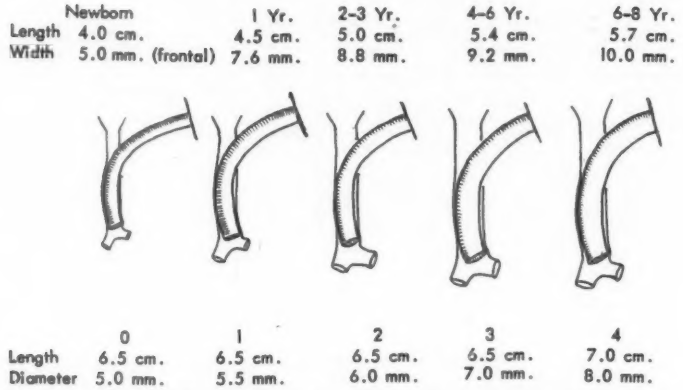

FIG. 1. Anatomical dimensions of the trachea (*top*) from the newborn infant through an eight year old child, and the discordant relationship as indicated by tubes (*bottom*) numbering 0 through 4.

trachea, it is still the best all-around arc to utilize for ease of insertion, minimum chafing and inner-outer tube sliding. Figures 1 through 3 show the discordant relationship between the trachea in children and the recommended tube numbers (by the manufacturers) for the various ages.

It is highly advisable that the danger of overlong tubes be corrected by cutting all the standard tubes down to the sizes recommended in Table II. The tubes can be easily revised to proper size in any hospital machine shop.

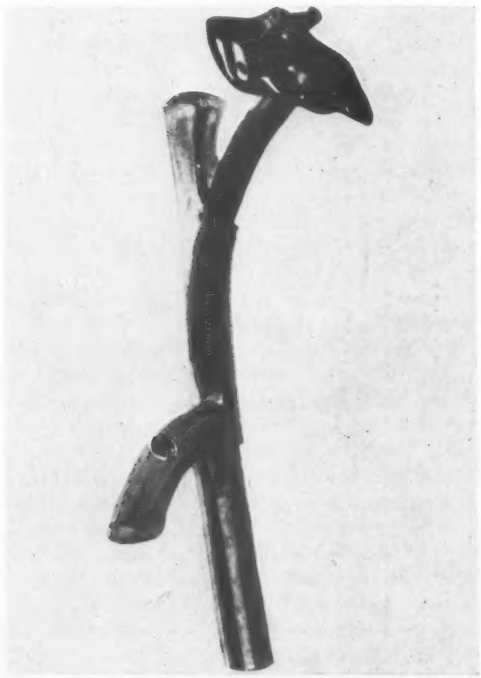

FIG. 2. Plastic model of the infant trachea showing the manner of impingement of a lengthy tube on the carina.

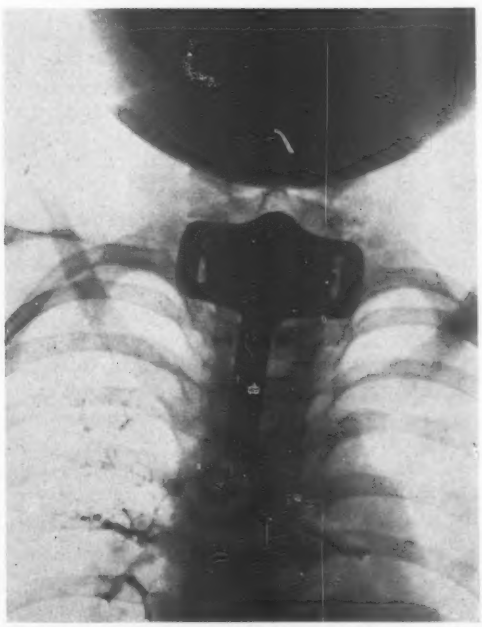

FIG. 3. Lipiodol study showing lengthy tube impinging on carina.

It is hoped that plastic tubes in infant sizes will be available shortly. Such tubes will be disposable and, in addition, will reduce the amount of tracheal irritation inherent in the use of metallic tubes.

The diameter of the tube to be inserted should be sufficiently smaller than the trachea itself so as to permit ample air space between the tube and the trachea, thus allowing the child to breathe easily when the tube is corked after the obstruction has been relieved. On the other hand, the lumen of the tube should be adequate to permit unlabored exchange. If corking causes obstruction because of an extremely tight fit, progressively smaller tubes can be utilized with daily replacement and eventual corking of the smallest tube.

The surgeon should always examine the instruments provided for the tracheostomy operation, for they are invariably set up for the adult patient and thus are too coarse for this delicate procedure in infants. In addition, the set-up is usually undersupplied.

The tray should contain: (1) mosquito clamps; (2) small sharp iris scissors and Stevens scissors, both curved and straight, as well as a small Metzenbaum scissors; (3) two vein retractors; (4) two small ribbon retractors; (5) two small hooks, a single prong and a double prong ¼ inch wide; (6) one small towel clip; (7) suction; (8) revised tracheostomy tubes from Nos. 0 to 4 with accurate adapters for the anesthetist's use; (9) Nos. 11 and 15 knife blades and a No. 3 knife handle.

TABLE II

PRESENT LENGTH AND CORRECTED LENGTH FOR TRACHEOSTOMY TUBES NUMBERS 0 THROUGH 4

Tube No.	Present Length (cm.)	Corrected Length (cm.)	Diameter (mm.)
0	6.5	4.5	5
1	6.5	4.5	5½
2	6.5	5.0	6
3	6.5	5.0	7
4	7.0	5.5	8

TECHNIC

The anesthesia in elective tracheostomy differs from that of emergency tracheostomy. The emergency tracheostomy is performed either with the patient under local anesthesia or without anesthesia. The elective tracheostomy usually precedes or follows a definitive operative procedure on the neck, face or head, or is performed more or less unhurriedly during the observation period. The patient is anesthetized by means of an endotracheal tube which greatly aids the surgeon, as it tends to steady the trachea during dissection. A sandbag is placed under the shoulders to permit full extension of the head. Midline positioning is mandatory. A horizontal incision 2.5 cm. in length is made through the skin 2 cm. above the sternal notch. Dissection is made with a mosquito clamp down through the linea alba between the ribbon muscles. All bleeders must be tied. The isthmus of the thyroid gland may be visible through the superior portion of the wound. Blunt dissection in the midline should expose the trachea with no difficulty. The pretracheal fascia is separated and, if needed, the isthmus of the thyroid gland is retracted upward. Downward dissection toward the thorax should be avoided and one should stay in the midline. Vein retractors or small ribbon retractors can expose the trachea easily. The sharp hook can grasp the trachea and a segment of sufficient size be removed from the anterior wall to allow the tracheostomy tube to be inserted. Suction is essential to prevent blood from entering the trachea. The anesthetist withdraws the endotracheal tube prior to inserting the tracheostomy tube. The wound is closed loosely with two or three No. 4-0 catgut deep sutures and No. 5-0 black silk skin sutures. It is advisable that the diameter of the tube be small enough to permit the passage of air around the tube while it is *in situ*. A tube that is too wide will not only obstruct the trachea completely but also may injure the mucosa. A gauze pad is split and placed between the skin and the head of the tracheostomy tube, after which the attached tapes are tied behind the neck.

Postoperative tracheostomy care demands a constant twenty-four–hour watch. The greatest cause for morbidity and mortality is poor postoperative care due to either neglect or ignorance. The responsibility must be divided among the anesthetist, the surgeon and the nursing team.

When surgery is to be performed, anesthesia is continued through the tracheostomy tube after withdrawal of the endotracheal tube. This is accomplished by inserting a well

Keep catheters separate in clean 5 percent sodium bicarbonate
SUCTION EQUIPMENT WITH "Y" FITTING
TURN HEAD RIGHT TO ASPIRATE THE LEFT BRONCHUS
TURN HEAD LEFT TO ASPIRATE THE RIGHT BRONCHUS
Insert catheter to maximal depth, with "Y" valve open. Pull catheter back about one centimeter to free tip from bronchus wall, and aspirate by closing the "Y" valve.
DON'T PINCH TUBE
While aspirating
DO USE "Y" VALVE
REMOVE CATHETER GENTLY... AT THE SAME TIME, ROTATING IT 360°. AVOID PROLONGED CONTINUOUS SUCTIONING.
IF CATHETER "GRABS" USE "Y" VALVE TO RELEASE SUCTION AND PREVENT MEMBRANE DAMAGE.

FIG. 4. The "regulated pressure" method of tracheal suction as described by Plum and Dunning [6]. Reproduced by permission of the authors.

fitting connecting tube into the tracheostomy tube. In this manner, the operating field is unencumbered and oxygen can easily be administered. It is the responsibility of the anesthetist to retain the child in the recovery room until he has recovered or the emergency has been overcome. Only then can the child be safely returned to regular floor care where again only trained nursing personnel should assume responsibility.

POSTOPERATIVE CARE

It is advisable for the surgeon to discuss personally his orders with the nursing personnel. In addition, he must be specific and precise in his postoperative instructions which should include the following points:

1. The tracheostomy tube tapes should be very carefully tied behind the neck of the patient.

2. The patient should be placed in an environment of high humidity and oxygen, and the temperature (75 degrees) carefully regulated. There are some, however, who believe that routine use of oxygen is contraindicated as it may tend to dry the secretions. Detergents and enzyme mucolytic agents are inconsistently used, for their value as irrigants and secretion thinners has not been conclusively proved. As a matter of fact, extreme thinning of the exudate can result in the patient drowning in his own secretions. Apparently, water vapor still liquefies the secretions most effectively.

3. The infant's elbows must be restrained, preferably by elbow guards, to prevent the catastrophe of the child's removing his own tube.

4. Frequent changes in position are necessary for infants, as they tend to assume a head-back position on one side.

5. Sedation should be in small amounts to keep the child quiet; on the other hand, the respiratory center must not be depressed.

6. The surgeon must insist upon adequately functioning suction.

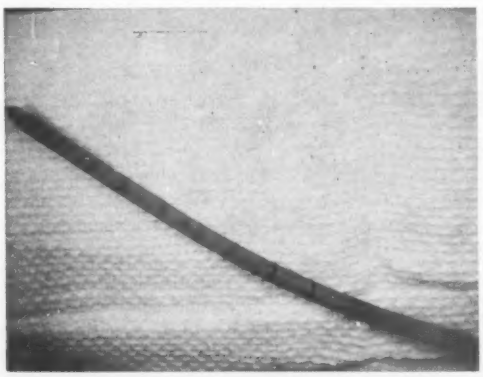

FIG. 5. No. 12 French catheter calibrated in centimeters. Manufactured by Davol Rubber Co., Providence, Rhode Island.

Each hospital should establish readily available sterile postoperative tracheostomy set-ups. The proper armamentarium should include a No. 12 to No. 14 whistle-tip rubber catheter (non-blunt) attached to a Y-valve which in turn connects to the suction. Two metal bowls are needed, one to receive 5 per cent sodium bicarbonate and the other, normal saline. The sodium bicarbonate solution moistens the catheter and aids in dissolution of the mucous secretions.

TRACHEOTOMY TUBE TREATMENT TRAY
(STERILE DATED)
AVAILABLE AFTER EACH TRACHEOTOMY

- 1 muslin wrapper, 36 inches by 36 inches
- 1 suture bag
- 1 Kelly clamp
- 1 large stainless steel tray
- 1 iodine cup
- 2 stainless steel bowls, 5 inches by 5 inches
- 3 towels
- 1 small emesis basin
- 6 gauzette sponges, 2 inches by 2 inches
- 6 gauzette sponges, 4 inches by 4 inches
- 6 pipe cleaners
- 1 connection for suction machine wrapped in towel
  - 1 piece of latex tubing, 30 inches
  - 1 piece of latex tubing, 15 inches
  - 1 ¼ inch connecting "Y" tube
  - 1 ¼ inch connecting plain tube
- 1 No. 12 whistle-tip red catheter marked at 7 cm. and 8 cm. from end
- 1 No. 14 whistle-tip red catheter marked at 7 cm. and 8 cm. from end
- 1 tracheal suction machine
- 1 quart 5 per cent sodium bicarbonate of soda

Issue instructions on tracheotomy treatment set with request.

In addition, an instruction sheet should accompany each set-up.

INSTRUCTION SHEETS TO NURSES
CARE OF TRACHEOTOMY
Read Carefully

Tracheotomy tube:

1. Secure loosely with tie around neck of patient.
2. Inner tube should be cleaned carefully three times a day. Wash in sterile saline.
3. Keep obturator in sterile gauze by patient's bedside in the event tube slips out and must be reinserted.

Humidification of air:

1. Air inspired into tracheotomy should be humidified by any of the more efficient systems available.
2. Infants should be placed in an Isolette® oxygen tent, Croupette® or comparable type of plastic compartment in which the temperature, humidity and oxygen concentration can be regulated.

Suction via tracheotomy tube:

1. Use a No. 12 or No. 14 whistle-tip rubber catheter (not blunt-tipped).
2. Lubricate in 5 per cent sodium bicarbonate solution (do not use dry catheter).
3. Scrupulous cleanliness must be observed at all times because of the serious danger of bacterial cross contamination. Personal hygiene must be strict and hands must be washed between suctioning procedures.
4. Keep nasal and tracheal catheters separate.
5. Insert Y-valve into suction line. Leave the Y-valve open when inserting the catheter. Insert catheter to full depth of bronchus, pull back 1 or 2 cm. to remove tip from mucous membrane before closing the Y-valve with the finger. Don't pinch the tube or catheter since this creates too much vacuum in suction bottle and will cause damage to mucous membrane when released.
6. In order to suction both main stem bronchi, insert tracheal tube and guide into right or left bronchus by turning chin to opposite shoulder.
7. Pull catheter out with rotary motion of 360 degrees, controlling suction carefully.
8. Allow a maximum of fifteen seconds for each aspiration. Allow a minimum of three minutes' rest between aspirations so as not to induce hypoxia. The frequency of suctioning is determined by the prevailing conditions.

Care of catheters:

1. Keep catheters in sterile containers filled with 5 per cent sodium bicarbonate.

The "regulated pressure" method of tracheal suction has been clearly demonstrated by Plum and Dunning [6], and should be the routine of choice in all cases of tracheostomy. (Fig. 4.) The catheter is inserted into the tracheotomy tube, leaving the Y-valve open so as to avoid any negative suction. The tube enters to a predetermined mark, usually 6 cm., and is then retracted slightly. (Fig. 5.) The Y tube is then closed off with a finger, and with a rotating motion the exudate can be sucked out. In order to suction the main stem bronchi, the tube should be directed into the left or right bronchus by turning the chin to the opposite shoulder and vice versa. Suction is accomplished with a rotary motion of 360 degrees as the catheter is being removed. Aspiration is not prolonged beyond fifteen seconds in order to avoid hypoxia. Although frequent suctioning is essential, this rate should be determined by the conditions met in each changing situation. Visual and auditory signs should guide the frequency of suctioning. Repeated rapid insertion and removal of the catheter, although necessary, can be devastating to the narrow, fragile trachea of the infant,

causing an almost impossible situation. The use of cortisone in minute doses has recently been life-saving in reducing the inflammatory response and thus breaking a vicious cycle. The inner tracheostomy tube should be cleansed at least three times a day in a saline solution, and the outer tube not changed until the third or fourth day. Thereafter, it may be changed daily. The appropriate sterile trocar should be available in the event that the tube is inadvertently dislodged, necessitating rapid reinsertion. Postoperative tracheostomy care is a twenty-four–hour job, and the nursing personnel attending the patient should realize that a momentary lapse can have a tragic sequence.

SUMMARY

Elective tracheostomy in children may be performed with safety if the surgeon is thoroughly acquainted with the anatomy of the region and the occasional anomalous situation. Practically all tracheostomy tubes in use today for children and infants are excessive in length. These unanatomical tubes should be revised for use in children between the ages of the newborn to twelve years, and in no instance should they be longer than 5.5 cm. The 90 degree tube, although unsatisfactory in some instances, still possesses the best arc. The tracheostomy tube should be of a smaller diameter than the trachea.

Serious consideration must be given to the performance of an elective tracheostomy in the following situations: (1) when there has been a difficult endotracheal intubation; (2) in surgery about the pharynx, larynx, tongue or mandible, when permanent or temporary respiratory obstruction may be a consequence; (3) in prolonged comatose states; and (4) in trauma to the respiratory tract or lungs, such as in a burn, when efficient respiratory toilet is essential.

Proper equipment set up conveniently in trays and including Y-tubes and marked catheters must be on hand at all times.

It is only by such continued and diligent attention to detail, as has been described, that the tragedies so frequently associated with this procedure may be averted.

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The Treatment of Osteoradionecrosis of the Mandible

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OSTEORADIONECROSIS of the mandible is a complex complication of radiation therapy for intraoral disease. Characterized by severe pain, trismus, fetor, ulceration and gradual sequestration, radionecrosis pursues a slowly progressive, indolent course and if untreated may produce drug addiction or chronic alcoholism. Unfortunately, this disease process is also frequently associated with recurrent malignancy, and both the clinical picture and prognosis become confused by the addition of a second major disease entity. In some published series [*1–5*] osteonecrosis of the mandible is associated with a high mortality rate. When analyzed, however, the mortality rate more often reflects the termination of an advanced malignancy rather than the end result of therapy for primary osteonecrosis alone.

Seventeen patients with primary radiation necrosis of the mandible not associated with recurrent malignant disease have been treated, without mortality, at the University of Kansas Medical Center since 1948. Study of the eitology, symptomatology and complications presents a picture of a progressive morbid disease process, the therapy of which can be individualized to provide a maximum of symptom relief and a minimum of serious complication.

ETIOLOGY

Since the time of Regaud [*6*], most authors [*2–4,7–9*] agree that the mandible is peculiarly susceptible to osteoradionecrosis. The thin, flat, anatomical structure with a single eccentric artery, the compact nature, the high calcium content which increases radiosensitivity [*3*], and the superficial location in the path of external radiation predispose to radiation injury.

In 1922 Regaud [*6*] first noted that osteoradionecrosis differed from osteomyelitis of infectious or traumatic origin. He believed that in bone injured by radiation, there was no distinct line of demarcation between dead and living bone, and that no involucrum formed until the disease process reached the limits of the radiated field where sequestrectomy and healing occured. This, he believed, was the result of a decreased vascular reserve which lowered the ability of bone to combat bacterial invasion.

Ewing [*7*], in 1926, stated that "complete death of bone of a peculiar type appears to occur in some cases after heavy external radiation by x-ray or radium" and that the necrosis, characterized by eburnation of bone, resulted from vascular sclerosis in the haversian system, the periosteum and surrounding soft tissues. There is concomitant death of the bone cells and intrinsic change in the lamellar substance due to secondary radiation effect which increased brittleness and predisposed to spontaneous fracture.

Warren [*8*], in review, emphasized four major points in the pathogenesis of osteoradionecrosis: (1) Radiation injury can occur beneath intact skin and mucous membrane. (2) The macroscopic integrity of bone is maintained even after heavy radiation due to amorphous mineral foundation. (3) Infection or trauma superimposed upon radiation damage produces marked necrosis. (4) Sequestration in radionecrosis is slower than necrosis due to infection or trauma alone.

Osteoradionecrosis of bone is thus the end result of the combination of radiation, infection

and trauma. The unique structure of the mandible and its anatomical position as an obstruction in the pathway of radiation therapy for oral carcinoma are the major factors in the frequency of this particular complication.

Necrosis on the basis of radiation alone seldom occurs. Although radiation damage may take place beneath intact skin or mucous membrane, the macroscopic integrity of bone persists even after extensive radiation, and sequestration occurs only with the addition of infection or trauma. The notoriously poor oral hygiene and high incidence of dental caries associated with intraoral malignancy provide a fertile ground for the bacterial invasion of a radiologically damaged mandible.

Dental caries, *per se*, may be a primary source of bacterial invasion or a cause of a delayed or "late" necrosis [*8*]. Tooth decay following radiation therapy may result from both radiologic injury to the pulp and decrease in the amount and pH of saliva [*10*]. This is a slow process which may provide the mechanism for osteoradionecrosis months or years following the primary radiation therapy.

CLINICAL PICTURE

Unremitting pain in the mandible is the most constant clinical finding in osteoradionecrosis whether primary or associated with recurrent malignancy. In early stages, the pain is associated with hypersensitivity of the remaining teeth and persists as a continuous toothache with associated alteration of taste. As the disease process progresses, the discomfort increases, characteristically, the patient complains of a deep, boring, persisting type of pain limited to the jaw which is not relieved by ordinary analgesics and is increased by the normal motion of talking or eating. Secondary trismus may be caused by pain, an intraoral ulcer or a pathologic fracture, or may be the result of muscular fibrosis caused by radiation and infection.

Ulceration with exposure of necrotic bone also occurs. Characteristically, the ulcer crater is deep, ragged and exquisitely tender, and there is marked inflammatory induration of the surrounding soft tissue. This may be extremely difficult to differentiate clinically from a recurrent malignant process which has secondarily involved bone. Multiple regional biopsies may be necessary for adequate pathologic differentiation. The ulceration may extend through soft tissue to form a persistent draining orocutaneous fistula. Fetor, too, is a constant companion of the oral ulceration, and the foul odor is an unending source of annoyance and discomfort to the patient.

Roentgen examination varies with the stage and extent of the disease process. The first evidence of radiation necrosis is periosteal thickening, followed by mottled areas of absorption and osteoporosis which may, in advanced cases, continue to pathologic fracture [*11*]. Involucrum formation and discrete sequestration is uncommon [*6*].

In addition, irritability, personality change, chronic alcoholism and drug addiction are frequently seen in patients with radionecrosis. The unremitting pain, oral fetor and inability to eat create a demand for relief which can, in many instances, be managed only by the continuous use of alcohol or narcotics.

PROPHYLAXIS

The prevention of radionecrosis of the mandible falls primarily into the province of the radiotherapist. Modern technics which include the use of intraoral cones, cobalt bomb therapy, careful shielding of uninvolved areas and in particular the fractionation of dosage may reduce the incidence of radiation injury.

Shultz [*12*], however, has shown that supervoltage therapy does not protect the mandible from damage when it lies directly in the path of proposed treatment for an intraoral lesion. Wildermuth [*3*] also advocated the use of radium when possible for he believed that by virtue of the short range effect of radium, plus direct application to a primary tumor, the amount of effective radiation to the mandible was lessened. In this series of 104 patients with intraoral malignancy, necrosis did not develop in any of those treated with radium. This experience, however, has not been paralleled by others [*1*] and is not borne out by the three patients with osteonecrosis presented herein who were treated by radium therapy alone (Cases 2, 3 and 5).

Since infection is an important etiologic agent and dental caries a constant companion of radiotherapy, prophylactic dental extraction has been widely advocated as an important measure to prevent radionecrosis [*2,10*]. Warren [*8*] has shown that external radiation causes cellular change which almost inevitably leads to caries in the pulp and cementum of normal

teeth. This fact, combined with the usual poor oral hygiene so frequently seen in intraoral carcinoma, has led to prophylactic extractions to reduce the portals of entry of infection. Wildermuth [3], however, has demonstrated convincingly that such extraction of teeth either immediately before or during radiotherapy promotes rather than prevents radionecrosis. The small spicules of bone which remain in the surrounding soft tissue of the alveolus following extraction form a nidus for inflammation and foreign body reaction and may well serve as a starting point for necrosis. In Wildermuth's series, all cases of radionecrosis occurred in the group who had prophylactic extraction either shortly before or at the beginning of radiation. Tooth extraction, if carefully performed under conditions of good oral hygiene with antibiotic therapy, has not resulted in osteonecrosis.

If intraoral malignancy exists in the presence of severe dental caries and poor oral hygiene, surgical treatment of the primary lesion would obviate the dangers of radiation therapy and concomitant dental extraction.

CLINICAL MATERIAL

Since 1948, seventeen patients with primary osteoradionecrosis not associated with recurrent malignancy of the mandible have been treated on the Plastic Surgical Service of the University of Kansas Medical Center. In fourteen patients radionecrosis developed following therapy for intraoral malignancy; the remaining three patients had radiation for benign lesions. All patients were treated surgically by either intraoral resection to bleeding bone or by extraoral mandibulectomy and subsequent reconstruction of orocutaneous fistula if present. The following cases are representative.

CASE REPORTS

CASE I. H. D. (KUMC No. 59-999), a sixty-seven year old white man, received 6,220 r of intra- and extraoral radiation for a squamous cell carcinoma of the floor of the mouth three days following full mouth extraction. The alveolar mucous membrane did not heal and gradually receded from the underlying mandible. (Figs. 1A and B.) X-ray examination revealed destruction of the mandible. (Fig. 1C.) Intraoral sequestrectomy was performed with preservation of the mandibular rim. (Fig. 1D.) Complete healing occurred with maintenance of contour. (Figs. 1E and F.)

CASE II. S. M. (KUMC No. 50-2718), a seventy-two year old white man, received 5,408 mg. hours of radium to a squamous cell carcinoma of the lip with marked local reaction. (Fig. 2A.) Three years following therapy, pain, ulceration and fetor developed, with exposure of the mandible.

Intraoral sequestrectomy to bleeding bone was followed by prompt healing and preservation of facial contour. (Fig. 2B.)

CASE III. F. F. (KUMC No. 55-5920), a fifty-three year old white man, received 6,400 gamma r of radium for epidermoid carcinoma of the tongue. Two years following therapy, dental extraction was performed without prophylactic antibiotic therapy and the alveolar mucous membrane did not heal. Pain, ulceration and severe trismus occurred (Fig. 3A) with x-ray evidence of a pathologic fracture of the mandible. (Fig. 3B.) Intraoral sequestrectomy was performed with primary soft tissue healing.

FIG. 1A. Case 1.

FIG. 1B. Case 1.

FIG. 1C. Case I.

CASE IV. R. M. (KUMC No. 55-7349), a fifty-two year old man with diabetes, received external and intraoral radiation for a carcinoma of the floor of the mouth, followed by bilateral suprahyoid dissection of the neck for metastases. Eighteen months later, following drainage of an abscess, a persistent orocutaneous fistula occurred with exposure of the mandible. (Fig. 4A.) Roentgen examination showed total destruction of the mandible from mid-body to mid-body. (Fig. 4B.)

Extraoral mandibular resection was performed. (Fig. 4C.) The orocutaneous fistula persisted but the patient has refused pedicle coverage.

FIG. 1D. Case I.

CASE V. O. A. (KUMC No. 51-3453), a seventy year old white man, received 5,930 mg. hours of radium for a squamous cell carcinoma of the oral commissure and oral mucous membrane. Eighteen months following radiation therapy, severe pain developed in the right side of the face and mandible, as did an orocutaneous fistula. (Fig. 5A.)

FIG. 1E Case I.

FIG. 1F. Case I.

FIG. 2A. Case II.

FIG. 2B. Case II.

FIG. 3A. Case III.

FIG. 3B. Case III.

FIG. 4A. Case IV.

FIG. 4B. Case IV.

FIG. 4C. Case IV.

FIG. 5A. Case V.

FIG. 5B. Case V.

Hemimandibulectomy was performed and pedicle reconstruction closed the persistent fistula. (Fig. 5B.)

CASE VI. J. G. (KUMC No. 51-20696), a seventeen year old white boy, received radiation therapy followed by subtotal resection of the mandible with bone graft for a "benign osteosarcoma" which proved on pathologic review to be an ossifying fibroma of the mandible. (Fig. 6A.)

Thirteen years following therapy, radionecrosis of the bone graft occurred with pain, ulceration and formation of a fistula. (Fig. 6B.)

Extraoral resection of the involved bone and

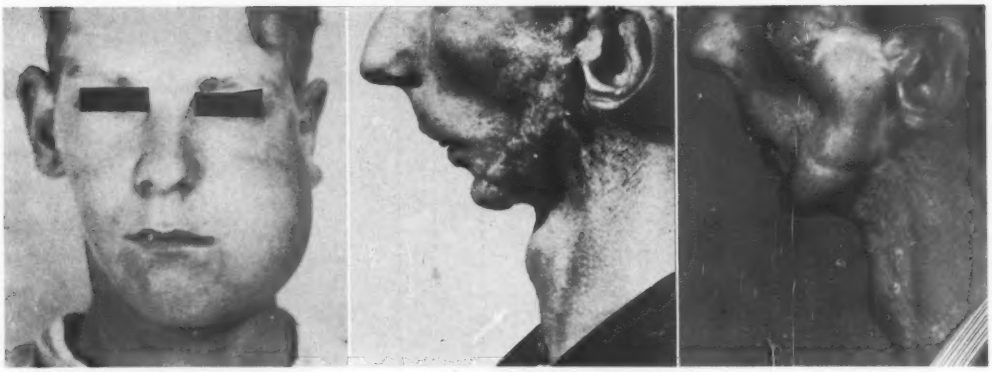

FIG. 6A. Case VI. FIG. 6B. Case VI. FIG. 6C. Case VI.

reconstruction with a tube pedicle graft produced relief of symptomatology and closure of the fistula. (FIG. 6C.)

TREATMENT

The treatment of osteoradionecrosis of the mandible is surgical. The surgical approach, however, depends not only upon the extent of the local disease process but also on the concomitant surrounding radiation injury to soft tissue, symptomatology and the presence or absence of recurrent malignancy.

Since radionecrosis is almost universally accompanied by ulceration, local inflammation of soft tissue and induration, the appearance of the inflammatory process may be extremely difficult to differentiate from recurrent malignancy. This distinction is essential. In the presence of malignancy, treatment should be directed, with rare exception, toward the eradication of cancer. In this instance, mandibular necrosis is of secondary importance and should not become a potential "red herring" in the therapeutic approach.

The condition of the surrounding soft tissue is an important surgical consideration. The notoriously poor healing qualities of radiated skin are well known, and if closure becomes a problem, some form of reconstruction such as a pedicle graft which brings with it an intact blood supply is the procedure of choice. Closure under tension or split-thickness skin grafting frequently fails because of the altered vascularity of the surrounding soft tissue. Such wounds may disrupt and, if the carotid vessels are thus exposed, fatal hemorrhage may occur.

Symptomatology itself often provides a concrete indication for surgical therapy, Gaisford [1] has shown that even in the presence of hopeless malignancy, palliation can be accomplished. The deep boring pain, trismus and ulceration which accompanies advanced radionecrosis often converts patients with widespread malignancy into confirmed narcotic addicts or alcoholics. This symptom complex is not a manifestation of the malignant process and often can be relieved totally by mandibular resection. Palliation of pain may be worth while even though the ultimate prognosis is hopeless.

The therapy of radio-osteonecrosis when unaccompanied by malignancy is a unique problem. The sparse literature reveals a conflict of opinion varying from conservatism to radicality. Kanthak [5] has stated that sequestrectomy should be performed when the dead bone separates or when a pathologic fracture occurs. Because of the avascularity due to the radiation injury, the mandible loses its capacity to form an involucrum and thus preserve continuity while sequestration occurs.

Once started, sequestration is a slow but inexorable process which will continue progressively but with no sharp demarcation as in osteomyelitis or trauma. This dying process often takes months or even years to occur, and the continued presence of pain, trismus, inability to eat and poor oral hygiene persists for the duration of the sequestration. Gaisford [1], on the other hand, advocates the immediate resection of all radiated bone at the onset of symptoms. In using an extraoral approach routinely, however, the poor healing qualities of the surrounding soft tissue led to hemorrhage from the carotid artery in four cases.

It is our belief that the treatment of radio-

osteonecrosis unaccompanied by malignancy should be carefully individualized. Although it is difficult to ascertain radiologically the extent of radiation injury, the presence of necrotic bone does not necessarily indicate mandibular resection. When possible, the involved mandible should be resected to bleeding bone, which on occasion will allow the preservation of at least a basilar rim of mandible for support to the floor of the mouth and the maintenance of contour (Cases 1 and 2). Although radiated mandibular periosteum may fail to regenerate the osseous continuity of the resected bone, an intraoral approach has been used when indicated to avoid the complications of surgery through radiated soft tissue. With careful selection, good postoperative oral hygiene and antibiotic therapy, the intraoral incisions have healed well and infection of the remaining mandible has not been a problem. If orocutaneous fistulas exist, however, wide resection associated with primary closure without tension, or followed by pedicle coverage later, has proved to be the procedure of choice.

Surgery should not be deferred once symptoms of radionecrosis have appeared. The inexorable nature of the disease militates against temporization and, perhaps, if resection to bleeding bone is performed early, partially damaged bone which is not subjected to low grade chronic infection over a long period of time may survive as its nutrition may be provided by surrounding soft tissue, free of infection and foreign body reaction.

SUMMARY

Osteoradionecrosis of the mandible is a common complication of radiation therapy for intraoral malignancy and results from a combination of radiation, infection and trauma.

Radiation injury presents a clinical picture of pain, trismus, ulceration and fetor which is amenable to specific surgical therapy.

Treatment depends upon the pathologic condition present. If malignancy exists, therapy is directed toward the ablation of carcinoma, although surgical excision of painful radiation necrosis may be a valuable palliative weapon.

Primary osteonecrosis not associated with malignancy, when each case is given carefully individualized attention, can be treated so as to produce dramatic relief of symptoms, with a low mortality rate.

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Mandibular Prognathism Corrected by Overlapping Open Vertical Osteotomies of the Rami

REPORT OF SEVENTY-ONE CASES

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THIS article presents the results of seventy-one cases of mandibular prognathism corrected by a surgical technic which I first performed in August 1954 [1]. Of the seventy-one procedures, fifteen were performed by residents in our Oral Surgery Training Program. Sixty-eight patients had congenital mandibular prognathism; in the other two, prognathism was of traumatic origin with bilateral angle fractures healed in malposition. One patient underwent correction twice at ages eighteen and twenty-one because of failure of intervening orthodontic treatment and possible additional growth of the jaw. Two patients had an associated cleft lip and palate. Two of the patients were identical twins. Following the surgical procedures, about 60 per cent of the patients required selective spot grinding, 34 per cent required the services of a prosthodontist, and 6 per cent underwent surgical correction as a preorthodontic requirement. Of the seventy patients, twenty-five were male and forty-five female. The ages varied from eleven to sixty years with an average age of twenty-eight. The range of prognathism was from 5 to 27 mm. with an average of about 11 mm.

METHOD

Accurate dental models are mounted on an articulator in an arbitrary postoperative position. Intermaxillary relationship alone dictates this position. If the future care of the patient is to be in the hands of an orthodontist or a prosthodontist, consultation regarding this postoperative position is advisable. The maxillary model is then moved forward 1½ mm. and an overcorrection of a 1 mm. opening is incorporated in the second molar area. A small acrylic splint is made to cover the occlusal and incisal edges. A day or two before surgery Erich type arch bars are placed on both arches and the splint is tried on each arch to check for any interference.

Surgery. On the right side, an incision approximately 3.5 cm. in length is made about 1.5 cm. below the right angle of the jaw. The skin and subcutaneous tissue and platysma muscle are divided. The tissues beneath the platysma muscle are divided by blunt dissection down to the periosteum of the lower border of the mandible. The nerve stimulator is intermittently used to make certain that the mandibular branch of the facial nerve is not severed. The periosteum is elevated from the lateral surface of the ramus until the anterior base of the condyle and mandibular notch are identified. A special retractor has been designed for exposure of this area. Using a nasal saw, the subcondylar osteotomy is made vertically from the deepest portion of the notch to a point 1 cm. above the angle on the posterior border. (Fig. 1.) After division, slight pressure on the chin starts the ramus in a posterior direction. The condylar fragment is kept laterally. The wound is temporarily closed. A similar procedure is carried out on the left side. (Fig. 2.) At this point the acrylic intraoral splint in the postoperative occlusal position is inserted between the arches of teeth and fixed by three 20/1,000 intermaxillary wires. The wounds are again opened to see that there is good contact of the bone and that

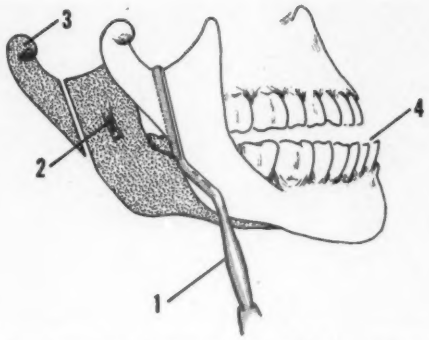

FIG. 1. Drawing of prognathic mandible. (1) The saw is in position for osteotomy of the ramus. (2) The mandibular foramen. (3) The condyle. (4) The protrusion of the lower teeth.

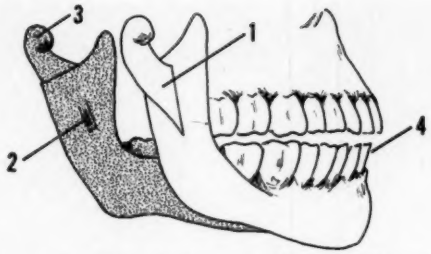

FIG. 2. Drawing of the prognathic mandible after surgery. (1) The condylar fragment is lateral to the ramus. (2) The mandibular foramen. (3) The condyle. (4) The prognathism is corrected.

the proximal fragment is lateral to the distal fragment. The deeper structures are closed by mattress type chromic No. 3–0 gut sutures. The skin is closed by a No. 35 stainless steel subcuticular pull-out wire. A bulky collar type bandage is placed over the wound. Operating time is about one hour.

Postoperative Care. All patients had their jaws wired together for seven weeks with one exception, in whom the intermaxillary fixation was removed at five weeks. The average period of hospitalization was four days, and time lost from work or school was two weeks.

Variations. On five occasions of severe prognathism, it was found that the rami were nearly parallel. The amount of overlapping produced a lateral displacement of the distal end of the condylar fragment. In two of these cases a second cut was made parallel to the first and a section of bone removed. This allowed the distal portion to fall medially and is similar to the procedure reported by Eubanks in 1957 [2]. In three cases the occlusal

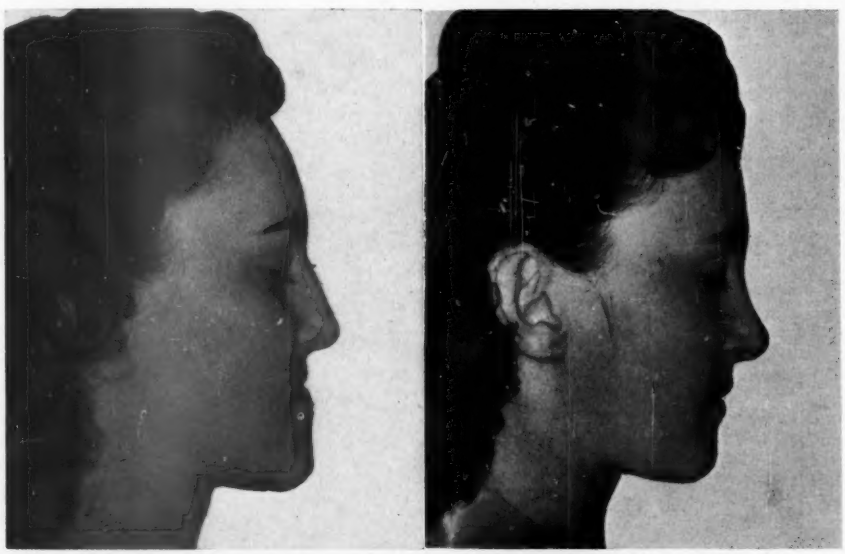

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FIG. 3. Preoperative photograph of patient. (Case 10.) Surgery performed in the Santa Monica Hospital.

FIG. 4. Postoperative photograph of the patient taken April 29, 1959.

FIG. 5. Case 10. The occlusion before surgery.

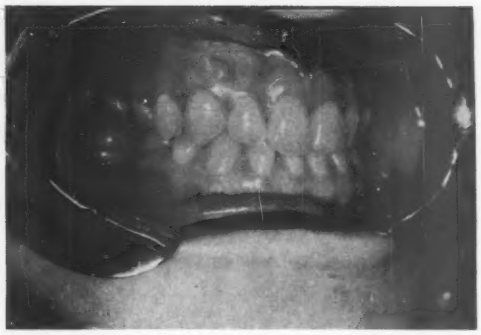

FIG. 6. Case 10. The occlusion two years and nine months after surgery. The mandible has been moved approximately 9 mm. posteriorly.

splint could not be placed. Three patients had full maxillary dentures and remaining lower anterior teeth. In these cases the fixation was from two interosseous maxillary wires to the bar of the mandibular arch, using the maxillary denture with quick cure acrylic in the palate in place of the splint.

ILLUSTRATIVE CASE

CASE 10. A twenty-seven year old white woman (Figs. 3 through 5) was referred by her plastic surgeon for correction of mandibular prognathism before the performance of corrective rhinoplasty. On July 10, 1956, the mandibular prognathism was corrected in the manner described herein. The collar bandage was removed on the third postoperative day, and the patient left the hospital on the fifth postoperative day. The subcuticular wire was removed on the tenth postoperative day. She returned to work on the fourteenth day. On September 19 a minimal amount of spot grinding was carried out on interfering bicuspid cusps.

The patient was seen last on April 29, 1959 (Figs. 6 and 7) and had no complaints. She stated at that time that the plastic surgeon had corrected her nasal deformity in February 1957.

COMMENT ON METHOD

A small interosseous wire was used between the fragments in Cases 3 and 4 bilaterally and unilaterally in Case 5. It was found that this interosseous wire was not necessary. The occlusal splint has been found to have several advantages. The arbitrary postoperative position may not be stable because of interfering cusps, missing teeth, etc. A splint also allows

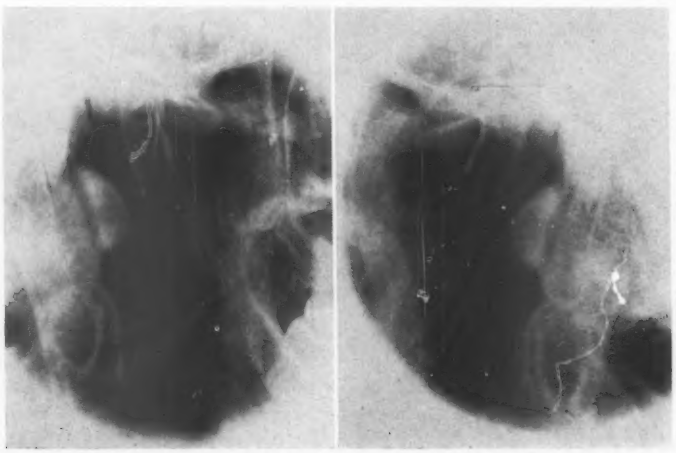

FIG. 7. Case 10. Postoperative roentgenograms show normal healing of the osteotomies.

for an overcorrection which appears to be necessary with this method. In cases 1, 2 and 3, there was no overcorrection incorporated in the splints and the results were 1, 2 and 1.5 mm., respectively, less than the desired result. Furthermore, the splint definitely saves time at surgery when bilateral wounds are open. Hinds [3] has reported good results without the use of the splint in nineteen cases. Since Case 4, all procedures have been performed under general anesthesia, with a Levin tube in place until the patient is fully awake. The condylar fragment should be kept laterally for two reasons: (1) The external pterygoid muscle will then tend to keep the fragments in contact and not displace them as it would if the condylar fragments were medial. (2) The flare at the rami makes the distance of the intercondylar neck more than the internotch distance so that the mandible can be moved posteriorly without gross displacement of the condyle. This is a modification of the closed operation reported by Kostecka in 1931 [4] and popularized in this country by Reiter in 1951 [5]. In 1955 Moose [6] reported one successful case in which surgery was performed by an open intraoral approach. Parker [7] has performed a similar extraoral operation through a small incision, placing the nasal saw on the internal surface and dividing the bone from within out. The hazards of blind surgery and the poor visualization offered by the intraoral approach prompted the adoption of this procedure.

RESULTS

A questionnaire was prepared which covered the points of pain in the joint, noise, trismus and bruxism. Physical examination covered opening, deviation on opening, function of the seventh nerve, tenderness, crepitus, facets of habit patterns and centric interference. Roentgenograms were taken using the Parma method. Of the seventy-one cases, one occurred in 1954, five in 1955, sixteen in 1956, twenty in 1957, twenty-one in 1958, and eight in 1959. The reported follow-up is of sixty patients. Three patients could not be located. The eight which took place in 1959 were eliminated for insufficient follow-up time. One thirteen year old girl (Case 11) had a moderate keloid tendency. Her scars were revised with x-ray treatment, with poor results. There were no other complaints regarding the appearance of the scar nor a flattened look to the chin such as is reported in ostectomies of the body of the mandible. There have been no delayed or non-unions or malocclusions of open bite. There have been no cases of hemorrhage and no cases of the proximal fragment being displaced medially, which have occurred in the blind procedure. One patient (Case 28) had pain in the right temporomandibular joint following surgery but it was relieved when partial dentures were made to replace her missing posterior teeth.

There were no other instances of pain in the joint, noise, trismus or bruxism. Approximately 25 per cent of the patients had some temporary paresis of the mandibular branch of the seventh nerve. In no case was this permanent and most instances were unnoticed by the patient.

The three cases (Cases 16, 39 and 70) in which the splint could not be placed were pre-denture patients with severe prognathism of over 20 mm. Satisfactory full artificial dentures were made, but it is thought that had these patients had natural dentition the postsurgical occlusion possibly could not have been adequately corrected by selective spot grinding. All roentgenograms showed normal healing.

SUMMARY

Seventy-one surgical procedures (in seventy patients) for the correction of mandibular prognathism by open vertical overlapping osteotomies of the ascending rami are reported. All results have been good and no serious complications have occurred.

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Bone Involvement in Maxillofacial Cancer*

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THE purpose of this study is to compile information concerning bone involvement in maxillofacial cancer. In textbooks and articles there is mention of extension of cancer into osseous areas. This research attempts to document data on the subject.

The following material and interpretation was made available by the study of eighty-one cases of maxillofacial neoplasms over a two-year period.

The main contribution of this work is to clarify the invasion of bone by malignancy through neurovascular channels. The observations presented may also offer a rationale for the clinical management of cancer of these areas.

MATERIAL AND METHODS

Patients having maxillofacial cancer were studied in the following manner:

1. The history was reviewed in detail in 118 cases, and eighty-one were selected because they could be analyzed completely. Primary carcinomas of various types from the mandible, maxilla and ear were evaluated. Osteogenic tumors, ameloblastomas, giant cell tumors, cysts, sarcomas and metastatic tumors were eliminated.

2. Of eighty-one specimens, forty-eight involved the mandibular bone, twenty-nine the maxilla, and four the ear region. In most instances of involvement of the mandibular bone, half of the mandible was included.

3. Macroscopic and microscopic examinations were made of all specimens. The microscopic evaluation was by serial sections as follows:

(a) In the mandible three representative regions were studied by longitudinal sections through the condyloid region (except when it was not included in the specimen); cross sections at the angle of the mandible in the region of the mandibular foramen; and in the body of this bone.

(b) In the maxilla, coronal sections were made in three regions, one at the infraorbital foramen, another in the mid-maxillary sinus area, and the third at the posterior area of the specimen.

(c) In the ear, cross sections were made of the cartilaginous part and bone chips from the mastoid process.

4. Clinical photographs were available in most instances and photographs of the surgical specimens were obtained in all cases.

5. Roentgenographic interpretations were compared with macroscopic and microscopic findings. For more adequate study, roentgenograms were made of the surgical specimens.

OBSERVATIONS

Three considerations are emphasized in the interpretation of the data. The first is the incidence of bone involvement; the second, and more fascinating, is the microscopic mechanism of involvement; the third is the comparison of roentgenographic and microscopic findings.

In Tables I, II and III, the percentage of incidence is analyzed. In Table I (general observations) it is seen that only twelve of the forty-eight mandibles examined had malignant involvement; this represents 25 per cent. From the twenty-nine maxillary specimens examined, on the other hand, twenty-four showed malignancy in bone, representing 83 per cent. In the ear malignancies, the small number of cases and insufficient tissue made interpretation question-

* First prize winner in the essay contest sponsored by Burroughs-Wellcome & Co.

able. This is understood when the anatomical limitation of this area is taken into account.

In Table II the favorite location of the neoplasm in maxillofacial bone is noted. It can be seen that the location is related to the more vascular areas. Also, in the same table are listed the recurrences which developed in malignant specimens.

Table III demonstrates the extension of nasomaxillary growths into the paranasal cavities.

The observation is made that in twenty of twenty-eight specimens examined there was extension into proximal regions.

The mechanism of bone involvement in maxillofacial cancer is by extension of the neoplasm along nutrient channels. In a study of many microscopic sections showing tumor in bone, the findings could be classified as early, intermediate and late stages of invasion. The earliest evidence of neoplasm appeared to occur in the stroma of the neurovascular systems, traveling within the periosteum and bone. An example of this is seen in the cross section of bone specimens in Figure 1, where malignant cells extend along the periphery of the vessel or nerve. In some portions only a few cells are seen free in the stroma. In others, the cells com-

TABLE I

GENERAL OBSERVATIONS, SHOWING INCIDENCE OF MALIGNANT INVOLVEMENT OF BONE

	No. of Specimens	With Malignancy	Free of Malignancy
Maxilla	29	24 (83%)	5
Mandible	48	12 (25%)	36
Ear region	4	1	3

TABLE II

LOCATION OF MALIGNANT INVOLVEMENT AND RECURRENCES

	No. of Specimens	Hard Palate	Alveolar Process	Nasal Cavity	Infraorbital Region	Recurrences
Maxilla	24	6	4	11	3	7

	No. of Specimens	Mental Foramen	Alveolar Process	Retromolar Space	Area of Mandibular Foramen	Recurrences
Mandible	12	1	4	3	4	3

TABLE III

MAXILLARY MALIGNANT TUMORS AND THEIR EXTENSION TO PARANASAL CAVITIES

Region	No. of Specimens	Extension to Paransal Cavities			No Extension*
		(Maxillary sinus)	(Orbital)	(Sphenoid-ethmoids)	
Nasal cavity	11	4	1	3	3
		(Nasal cavity)	(Maxillary sinus)		
Hard palate	6	1	3	.....	2
		(Maxillary sinus)			
Alveolar process	4	3	.....	.....	1
		(Maxillary sinus)	(Nasal cavity)	(Orbital cavity)	
Infraorbital	3	1	0	2	0

* Five-year evaluation is not included, since the purpose of this project was confined to determining the presence and mechanism of malignant involvement of bone.

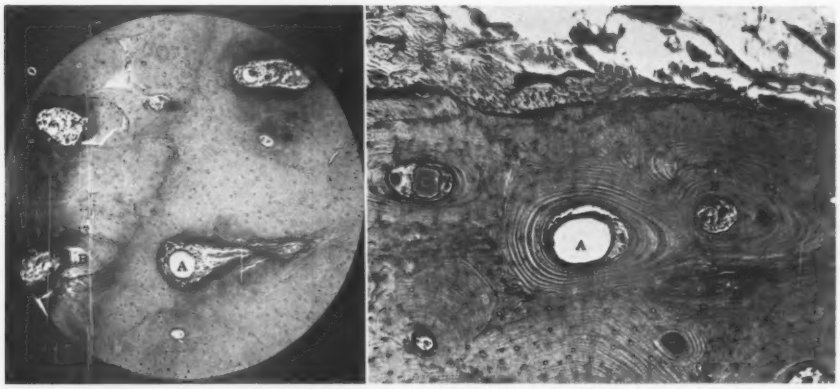


FIG. 1. Microscopic photographs of cross section of mandibular bone invaded by malignancy. A = few cells in the vascular and perivascular area of the haversian canal. B = complete obliteration of the vessels by cells. C = edema and reactions of the vascular system.

FIG. 2. Early malignant invasion of a Volkmann canal which is anastomosed with a haversian system.

FIG. 3. Active malignant development in a blind Volkmann canal.

FIG. 4. High power magnification of part of Figure 3 showing activity of malignant cells (A), osteoclasts in an osteolytic process (B), and the reaction of the bone tissue by formation of osteophytic zones (C).

pletely infiltrate the soft tissue channels. This type of section does not reveal whether or not cells are extra- or intralymphatic.

How this invasion proceeds is further demonstrated in a longitudinal section (Figs. 2, 3 and 4) where a Volkmann canal shows tumor cells proceeding along the vessels. It follows that the invasion continues unless blocked by a blind canal. The canaliculi of Volkmann's canal usually anastomose with the haversian system. In Figures 5 and 6 an invasion of this system with the beginning of invasion of the bone marrow spaces is seen. Osteoclastic activity, osteophytic zones of bone and, in advanced stages, destruction of trabeculae and sequestral formation are noted. The next step occurs when the invasive cells reach the main neurovascular system within the bone. Figures 7, 8 and 9 demonstrate a cross section of the mandibular

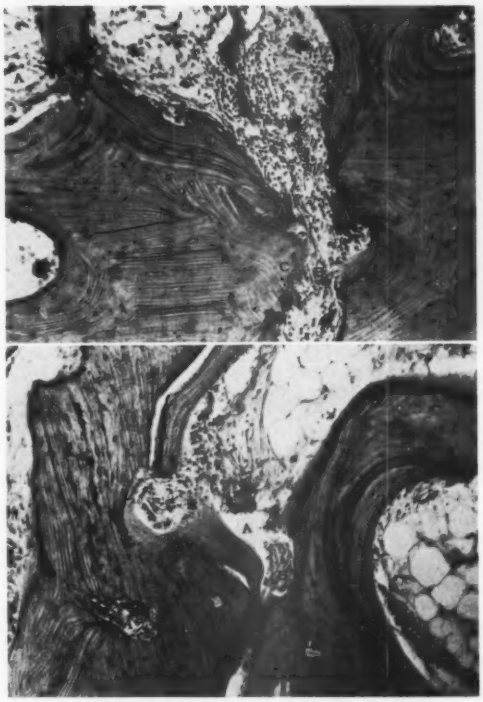


FIG. 5. Involvement of haversian systems with extension of the pathology to the bone marrow spaces. A = malignant process with result. B = bone distortion. C = effort of resistance by the living bone tissue forming zones of osteophytic type.

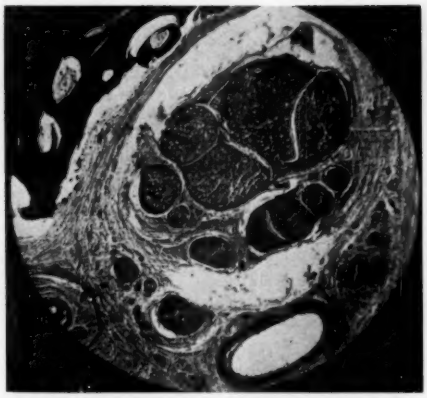


FIG. 7. Cross section of the mandibular canal close to the mental foramen showing normal architecture.

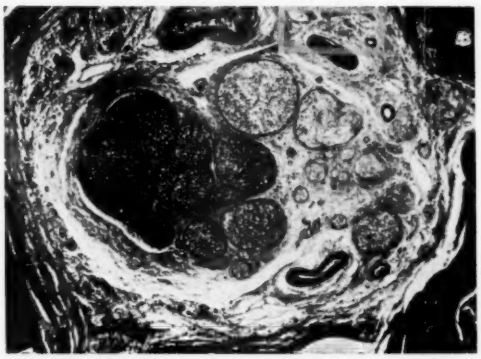


FIG. 8. Same location of the mandibular canal in a full tumor activity. The large neurovascular channel represents an expressway for invasion throughout the canal and marrow spaces.

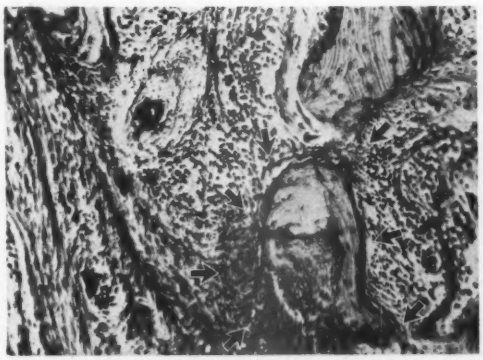


FIG. 6. The bone marrow is invaded, the bone functional lines and trabeculae are distorted, and sequestral formation isolated by neoplastic activity is seen.

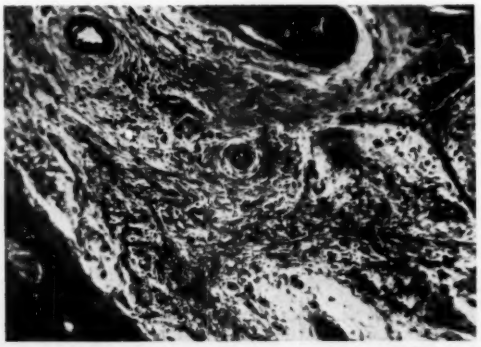
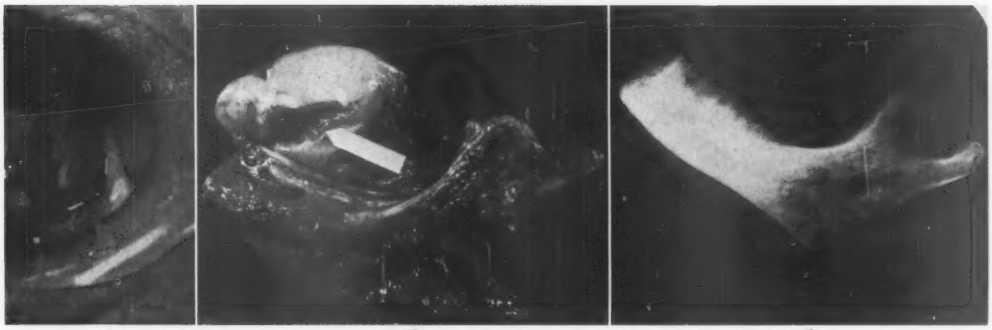


FIG. 9. High power magnification of a section of Figure 8 demonstrating the vigorous activity of the invading malignancy.



10A 10B 10C

FIG. 10. A, malignant lesion of tongue with extension to floor of mouth. B, the *en bloc* surgical specimen. C, roentgenogram of removed half of the mandible shows no malignancy. No microscopic malignancy was found.

canal close to mental foramen, the first showing normal architecture and the last two showing the tumor in full activity. This large neurovascular channel represents an expressway for invasion throughout the canal and marrow spaces.

It was noted in the previously mentioned findings that the nasomaxillary area is more frequently involved by tumor. The microscopic observations in general support this phenomenon. The richer the vascularity, the greater the possibility of invasion.

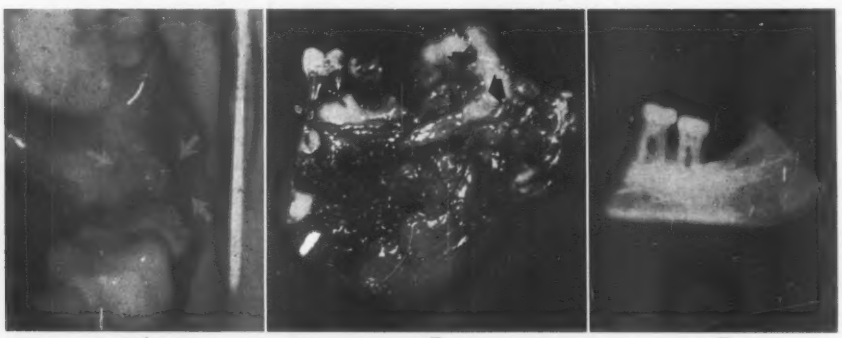
The third main observation is a brief comparison of the roentgenographic and microscopic findings of the cases studied. It was found that the roentgenogram did not always reveal the true status of involvement of the bone. In some instances the bone was reported as negative, and the surgical specimen proved to be positive. An example is given in Figure 10 in which the mandible is normal in a lesion of the tongue. On the other hand, in Figure 11 is shown a retromolar lesion in which the bone was involved microscopically but was negative roentgenographically.

Of the twenty-four specimens from the nasomaxillary area, nineteen showed involvement roentgenographically. In the twelve specimens from the mandible showing malignancy, nine were negative in the roentgenogram.

COMMENTS

Numerous authors have expressed opinions concerning the status of the bone in maxillofacial tumors. Lederer [*1*] states that the bone is frequently involved in the oral cavity when lesions of the gum and cheek are associated. Mulligan [*2*] adds that "the maxillae and mandible are invaded by way of the alveolar sockets." The findings presented herein corroborate these points of view.

An attempt has been made to explain a



11A 11B 11C

FIG. 11. A and B, carcinoma from left retromolar area in which malignancy was found in bone. C, roentgenogram fails to show involvement.

mechanism which accounts for the spread of tumor in bone. Resorption is more than a pressure from enlargement of the tumor, as has been expressed by Weinmann and Sicher [3]. It is, rather, a biochemical reaction, probably involving enzyme, vitamin, hormonal and possibly viral inter-relationships [4–8] in which the pathway of advance is along neurovascular channels. The stroma adjacent to the bone is probably no longer normal.

Ackerman and Del Regato [7], in referring to the rate of involvement, believe that the density of the bone plays a part in the spread of tumor. The present study suggests that density is a factor when blood supply is limited, but a tumor can easily spread through the available canals; the neurovascular channel is the important factor. Take, for example, a growth on the floor of the mouth approaching the mandibular bone. The tumor cells eventually reach the deep connective tissue, known as periosteum. This latter is rich in vascularity and allows easy infiltration. When the osseous structure is reached, the rhythm and rate of advance are disturbed.

For better understanding, the invasion is divided into stages. The first occurs when the malignant cells reach the bone. The bone cannot be destroyed by the malignant cell itself. After a temporary delay a second stage begins. This is when the cells find the vascular channels leading to the bone. At this point the bone is involved but the roentgenographic findings are negative. The third stage occurs when the main nutrient channels are reached.

From the data studied it might be implied that bone has been sacrificed needlessly. It must be understood, however, that the problems of surgical closure of a wound are important. In a mandibular lesion, for example, approximation of the soft tissues is often better performed when the bone is absent. Perhaps there is need for different surgical approaches.

In comparison, the maxillary bone, which is cancellous, is involved more readily and more extensively than the cortical type of bone. In surgery, the malignant tumor does not follow the accepted limitation of various surgical fields.

SUMMARY

1. Eighty-one specimens of maxillofacial malignancy with bone involvement were studied over a two-year period.

2. Mandibular bone was involved in 25 per cent and maxillary bone in 83 per cent as revealed in serial sections of bone specimens.

3. The mechanism of bone involvement is by extension through the neurovascular channels.

4. A comparison of roentgenographic and microscopic findings revealed microscopic involvement in some instances in the absence of roentgenographic findings.

5. From this study it is not possible to predict malignant involvement of maxillofacial bone in all instances.

Acknowledgment: I wish to express my gratitude to the National Institute of Health for offering me the opportunity for training, and to Professor Francis Lederer, under whose guidance the present study was completed.

Drs. C. A. Krakower and P. B. Szanto freely offered their laboratory facilities and personal scientific advice; Dr. R. Borkenhagen aided immeasurably in editing the data and manuscript, and considerable assistance was given by the Staff of the Otolaryngology Research Laboratory in the preparation of the material.

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Tumors of the Major Salivary Glands

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MOST tumors of the major salivary glands are not radiosensitive. Treatment of these tumors is surgical. In tumors of the submaxillary salivary gland the problem is simple, and the procedure is total resection of the gland and its contained tumor, with the adjacent lymph nodes when indicated. Anatomically resection is not difficult. The gland is enclosed in a capsule and can easily be completely removed. There are three nerves adjacent to the gland which should be preserved if possible: the mandibular branch of the facial nerve, the hypoglossal nerve and the lingual branch of the trigeminal nerve. The same treatment holds true for both benign and malignant tumors. In malignant tumors it may be necessary to combine resection of the submaxillary salivary gland with resection of surrounding tissue and radical neck dissection, if there is any indication of spread beyond the gland itself. In the cylindromatous type of adenocarcinoma one may also advise postoperative radiotherapy, although its value may be questionable.

In the parotid gland the treatment is more complicated because of the anatomical arrangement of the gland. The gland is divided into two lobes, a larger external lobe covered by a capsule and a smaller, deeper, non-encapsulated portion. The two portions of the gland are connected by an isthmus, and the facial nerve and its branches run between the two lobes, on both sides of the isthmus. Branches of the external carotid artery and the posterior facial vein run deep to the facial nerve. Because of the complicated anatomical relationships, some physicians hesitate to advise removal of the parotid gland. This has caused many to treat tumors of the parotid gland by enucleation. Proper treatment of tumors of the parotid is resection of the gland. If the tumor is located in the superficial lobe, superficial lobectomy is all that is necessary. If the tumor lies deeper, total resection of the gland should be performed. In both cases the facial nerve should first be located and the gland dissected free from the nerve. There are several technics of locating the facial nerve. It may be located as the distal branches emerge from beneath the anterior border of the gland [*3,7,9*], and then the branches followed posteriorly. Another technic is to locate the mandibular branch of the facial nerve [*1,8*] and follow it centrally. A third method [*2*] is to start in the region of the posterior facial vein and locate the nerve as it passes superficial to the vessel. Another technic [*4,6*] is to locate the facial nerve after it leaves the stylomastoid foramen and trace it distally. In most of our cases, because of the location of the tumor, it has been necessary to use more than one method, isolating the facial nerve both centrally and distally and tracing it both ways toward the central portion. When the tumor is malignant, preserving the facial nerve should be secondary to complete removal of the tumor. When the tumor is benign, preservation of the facial nerve should be of primary importance. When it is necessary to cut the facial nerve or remove a section because it enters the tumor, it can be reunited by suturing. Suturing of the nerve may be a primary union between cut ends of the nerve. If a large section of nerve has to be sacrificed, a bridge of nerve graft can be used. The greater auricular nerve is isolated and has to be cut when exposing the parotid gland for resection. A portion up to 2 or 3 cm. can be used if necessary, although it is rarely necessary to use more than a 1 or 2 cm. section.

If resection of the facial nerve has to extend centrally, so that no part of it can be used for resuturing, a cross nerve graft can be used. The hypoglossal nerve, part of the hypoglossal nerve, the descendens hypoglossi or the spinal accessory nerve can be used. I have successfully used the spinal accessory nerve, sectioning it and anastomosing the distal end to the terminal branches of the facial nerve. In time the

facial muscles can be re-educated to function properly.

SURGICAL TECHNIC

A preauricular incision is used, extending below the lobe of the ear and curving backward to the mastoid process. The incision then curves downward along the anterior border of the sternomastoid muscles, then anteriorly in the upper neck in the direction of the skin lines. The skin flap is elevated anteriorly beyond the anterior extent of the parotid gland. It can be elevated either bluntly with a curved sissor or by sharp scalpel dissection. The gland is dissected free from the anterior and inferior surface of the cartilaginous portion of the external auditory canal. The closer dissection is to the cartilage, the less bleeding encountered. The upper portion of the anterior border of the sternomastoid muscle is then dissected free, thus freeing the tail of the parotid gland. The parotid gland is elevated posteriorly, keeping the dissection close to the anterior surface of the mastoid process. Next, the facial nerve is located. It is usually found about 1 cm. above the tip of the mastoid process, by dissecting anteriorly toward the ascending ramus of the mandible and entering the parotid gland to find the nerve. The main trunk is located and the superficial portion of the parotid is dissected from the nerve and removed. In performing total parotidectomy for benign conditions, the deeper portion of the gland can be removed piecemeal from about and deep to the nerve. Occasionally the nerve trunk and its branches can be dissected free so that the entire deeper portion of the gland can be removed from beneath the nerve as one section. When there is a malignant tumor present, removal of the gland is most important and nerve preservation is secondary. When necessary the nerve can be sectioned, allowing total removal of the gland, and the nerve is then resutured.

In the present series reported there were 116 cases of resection of the major salivary glands: ninety-seven parotid and nineteen submaxillary salivary gland resections. (Table 1.) It includes mainly primary tumors of the involved glands; the few secondary tumors included are those in which the presenting location was solely in the local areas either parotid or submaxillary. No cases of submaxillary sialadenitis or sialothiasis were included. The tumors of the submaxillary gland were distributed as ten malignant and nine benign. The parotid tumor series included eighty benign conditions and seventeen malignant. (Tables II through IV.)

TABLE 1

Type of Tumor	Parotid Gland Resection	Submaxillary Gland Resection
Benign		
Mixed tumor		
Primary	33	..
Recurrent	8	5
Total	41	..
Papillary cystadenoma lymphomatosum	9	..
Papillary cystadenoma	1	..
Benign lymphoepithelial	1	..
Lipoma	2	..
Hemangioma	2	..
Hemangioendothelioma	1	..
Adenoma	3	..
Cysts	10	..
Inflammatory	10	4
Total	80	9
Malignant		
Unclassified carcinoma	5	1
Cylindroma	3	4
Malignant mixed tumor	3	1
Mucoepidermoid carcinoma	3	2
Malignant lymphoma	1	2
Metastatic carcinoma (melanoma, hypernephroma)	2	..
Total	17	10
Total	97	19

There were forty-one benign mixed tumors of the parotid gland, thirty-three primary, and eight secondary or recurrent tumors. Thus far there have been no recurrences in the patients with primary mixed tumors, and one recurrence in the eight patients with recurrent tumors. This recurrence took place in the superficial portion of the masseter muscle one year after total parotidectomy was performed for recurrent mixed tumor. The original surgery consisted of enucleation about eight years prior to the total resection. The patient had no facial paralysis at any time. She did have an auriculotemporal syndrome consisting of gustatory

TABLE II
DATA ON NINE CASES OF PAPILLARY CYSTADENOMA LYMPHOMATOSUM

Data	No. of Cases
Sex	
Males	7
Females	2
Side affected	
Right	3
Left	6
Age: 47–74 yr. (average, 59 yr.)	

TABLE III
DATA ON FORTY-ONE CASES OF MIXED TUMORS OF THE PAROTID

Data	No. of Cases
Sex	
Males	16
Females	25
Side affected	
Right	23
Left	18
Age: 21–80 yr. (average, 46 yr.)	

TABLE IV
DATA OF SEVENTEEN CASES OF MALIGNANT TUMORS OF PAROTID

Data	No. of Cases
Sex	
Males	6
Females	11
Age: 27–73 yr. (average, 51 yr.)	

sweating and redness while eating which developed about four months after the total parotidectomy. This was also present shortly after the last operation.

Careful questioning in the last few years revealed that the auriculotemporal syndrome is more common than previously reported. It occurred ten times in the last forty parotid resections. No satisfactory method of treatment has been accepted as yet.

SUMMARY

1. The proper treatment of tumors of the major salivary glands is resection of the gland.

2. In the parotid gland, if the tumor is in the superficial lobe, superficial lobectomy is the proper treatment.

3. Parotid tumors are five times as common as submaxillary tumors.

4. Parotid tumors are more apt to be benign, and submaxillary tumors are more apt to be malignant.

5. Preservation of the facial nerve is most important when dealing with benign conditions.

6. In malignant tumors preservation of the facial nerve is secondary.

7. The auriculotemporal syndrome of gustatory sweating is a common complication of resection of the parotid.

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Pathologic Features of Neoplasms of the Salivary Glands

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THE subject of neoplasms of the salivary glands has been so thoroughly covered by several investigators, namely Foote and Frazel [1], Stout [2] and Ackerman [3], that we hesitate to elaborate on it. We do wish to express our thoughts regarding some of the concepts offered by the aforementioned authors on those ideas which differ from ours. On strictly histologic criteria we offer what may be a complete and yet a simple classification. As a rule, a new listing does not necessarily indicate progress. However, the one subsequently offered may prove useful.

The material used as the basis for our ideas is not extensive, but it is diversified enough and in sufficient numbers to justify drawing conclusions or making interpretations. Each one of us has worked in different institutions and has had the opportunity to see many more tumors of the salivary glands than those which are included in this group. There has been ample time for follow-up to determine the outcome of some of the more controversial entities. Even so, there is some statistical weakness here and many patients have been lost to follow-up.

There are 209 tumors in our collection. For personal reasons we avoid the use of "benign" in these and other lesions in medicine. Hence, in arriving at a basic classification we have followed the accepted procedure of using non-malignant and malignant as the two major groups. The listing is shown in Table 1.

Photomicrographs are included to demonstrate what we believe are characteristic aspects of each form. (Figs. 1 and 2.) Some of them may be open to question. However, they do represent what we believe to be as correct an interpretation as is possible. Multiple sections have usually been performed and special stains utilized when necessary. Neither tissue culture nor animal transplantation tests have been made.

Clinical data have been studied but are not presented herein except for some specific reason. Fundamentally, the patients whose specimens

TABLE 1

Lesions	No. of Cases
Non-malignant (150 cases)	
Pleomorphic adenoma (mixed tumor)	117
Papillary cystadenoma lymphomatosum	21
Adenoma (pure) (oncocytoma or acidophilic)	6
Hemangioma	1
Lymphangioma	1
Lipoma	2
Neurilemmoma (schwannoma or perineural fibroma)	2
Malignant (59 cases)	
Pleomorphic adenocarcinoma (malignant mixed tumor)	15
Mucoepidermoid	11
Carcinoma	
Basal cell (cylindroma)	2
Adenocarcinoma (alveolar, papillary, clear cell)	5
Squamous	8
Undifferentiated (anaplastic)	4
Sarcoma	
Lymphosarcoma (includes leukemia and Hodgkin's disease)	4
Rhabdomyoma	2
Angiosarcoma	1
Leiomyosarcoma	1
Neurosarcoma (malignant schwannoma)	1
Secondary	
Malignant melanoma, squamous, adenocarcinoma	5

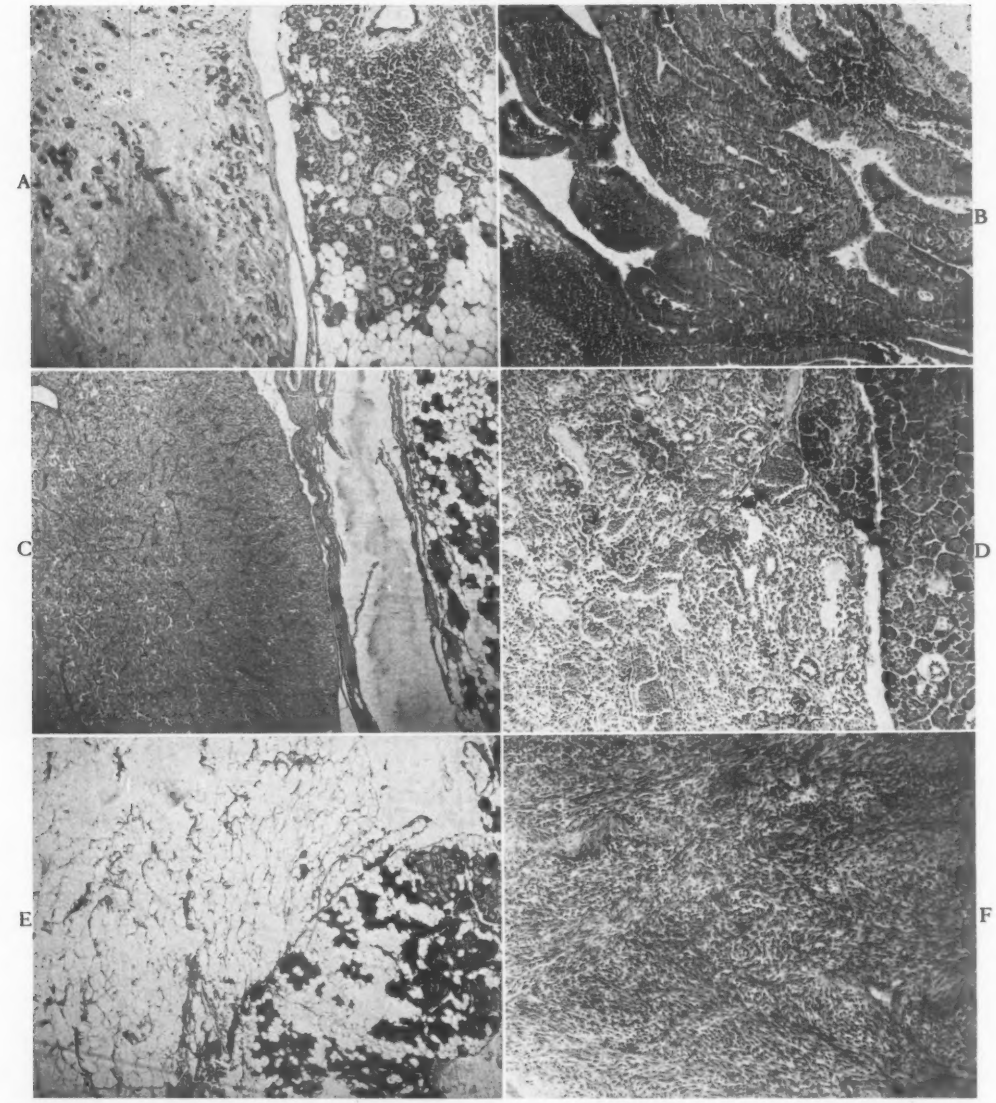

FIG. 1. A, pleomorphic adenoma of salivary gland. B, papillary cystadenoma lymphomatosum of salivary gland. C, adenoma (oncocytoma) of salivary gland. D, hemangioma of salivary gland. E, lipoma of salivary gland and F, neurilemmoma of salivary gland. Hematoxylin and eosin stain. Original magnification, × 100.

have been received for study consulted the attending surgeons because of tumor masses in or near the respective salivary glands. The duration of time varied from months to years. Some tumors had recently increased rapidly in size. Pain was not often present. Some tumors were in the mouth and of course these caused some problems in mastication or swallowing. A few patients had been operated upon previously. In these instances attempts were made to review the previous histologic slides; sometimes these were associated with failure. Occasionally the patients had been operated upon in a physician's office and thus

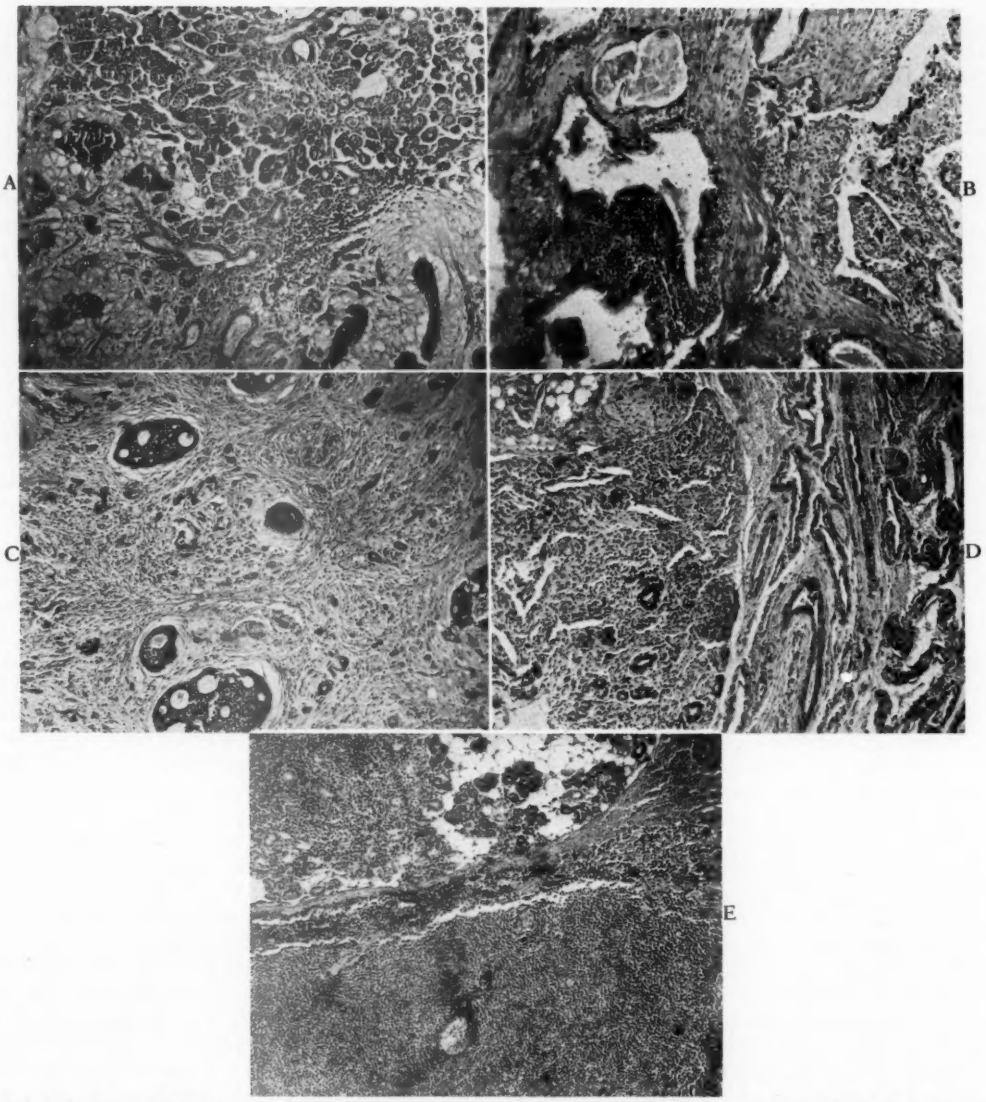

FIG. 2. A, pleomorphic adenocarcinoma of salivary gland. B, mucoepidermoid tumor of salivary gland. C, basal cell carcinoma (cylindroma) of salivary gland. D, hemangioendothelioma of salivary gland. E, lymphosarcoma in salivary gland, primary site. Hematoxylin and eosin stain. Original magnification, × 100.

the tumors were not always subjected to examination. A few had been incised and drained first, without success. Perhaps more stress should be laid upon teaching medical students about diseases, especially tumors, of the salivary glands. Errors in therapy could then be avoided.

COMMENTS

Some 25 per cent of the tumors are considered to be malignant. This approximates those studied by Stout [2] but is less than the figure of Foote and Frazell [1].

As anticipated, the largest group were the

pleomorphic adenomas, formerly and still designated as mixed tumors. Reasons for eliminating the stromatous portion of this neoplasm as a component in the new growth have been offered many times and have been readily accepted. Hence it is a variegated adenoma. The question as to whether these are all malignant from the start has also been thoroughly analyzed. We prefer to be conservative and to consider them as non-malignant tumors which have a higher potential for cancerous transformation somewhat similar to adenomas of the thyroid, vesical papillomas and intestinal polyps. If properly and adequately excised, recurrence is rare. There is often the thought that origin is from a small separate adenoma which has proliferated. Certainly, in any large series of autopsies there are few instances in which death has resulted from invasion or metastases from a true pleomorphic adenoma. Diligent study should reveal histologic evidence of malignancy in these cases.

In most of those lesions which we have considered to be malignant, there is usually a story of presence for some time, sudden increase in size and perhaps pain (due to compression of nerves). Our criteria of malignancy are no less nor more demanding than those of others who have studied this subject. In one specific case in which there was recurrence in five years, review of the original slides showed an error in interpretation at that time; the tumor was malignant on that occasion. In another case, when we insisted on the diagnosis of malignancy against the views of others, it was possible to demonstrate metastasis in lymph nodes.

We also subscribe readily to the concept that there is a higher incidence of malignant change in the aberrant pleomorphic adenomas, particularly in the oral cavity. Although these do not metastasize readily, they do extend to adjacent tissues and organs to cause death by infection, starvation or general debility.

The true adenomas present minimal difficulty in diagnosis. They are firm, encapsulated, have minimal fibrous stroma, none to slight mucinous material and when studied, are completely cellular with no evidence of any microscopic activity.

Angiomas, myomas, lipomas and tumors of the nerve sheath are the same in the salivary glands as elsewhere. Because of structural characteristics these are readily identified.

In a prior study, a certain number of papillary cystadenoma lymphomatosa were analyzed. Incidentally, one of these had demonstrated a similar entity on the opposite site. Although a true tumor on the basis of swelling, some consideration should be given to the thought that these are actually developmental defects rather than new growths. However, since the original presentation, we have seen one case from another hospital in which actual malignant change has occurred in a Warthin's tumor. This man had been operated upon several times and on recent questioning at the time of this writing, will require further surgical intervention because of recurrence.

Following the suggestions of others we have placed mucoepidermoid tumors in the malignant group. This entity was diagnosed eleven times which may be high in relation to the other researchers. However, we believed that microscopically the tumors fitted in this class.

We divided the carcinomas as listed. Perhaps there should be more of the so-called "cylindromas" (we believe that these simulate basal cell carcinomas in character and behavior) but we interpreted only two of them. The others, adenocarcinoma, squamous carcinoma, and undifferentiated carcinoma were not too difficult to diagnose. Most of the clinical data were also present. Some patients have died of the disease, others have suffered recurrence and still others have been lost to follow-up.

There were four cases in which the diffuse character of leukemia and lymphosarcoma presented first in the salivary glands. Subsequently in all of these patients generalized manifestations occurred. However, at the time of presentation no other evidence was found.

One case of rhabdomyosarcoma, one case of angioendothelioma and one malignant neurilemmoma are also included. On this basis we believe that malignant tumors of the connective tissue arise from the salivary gland structures. Despite contrary comments, we do not see why such a lesion cannot occur.

We have seen two instances in which malignant melanomas metastasized to the salivary glands and three cases in which carcinomas (one adenocarcinoma and two squamous carcinoma) metastasized from other sites—the oral cavity and lung. Were the salivary glands routinely studied at autopsy, no doubt more metastases would be determined. Our cases were determined clinically in the presence of known

metastases. Invasion from neighboring oral carcinomas is fairly common.

Because of an active surgical service on the head and neck, we have had numerous requests to perform frozen sections on these tumors for immediate diagnosis, either to verify the clinical impression of the surgeon prior to more extensive surgical procedures, or to ascertain whether or not the neoplasm was adequately excised. To aid the surgeon, the diagnosis should include not only a statement of malignancy or non-malignancy but also the histologic type of the tumor, i.e., a mucoepidermoid tumor, a pleomorphic adenoma, a carcinoma of the cylindroma type, etc. We wish to emphasize the need of making such a diagnosis based on well prepared and stained sections to minimize errors in interpretation or in giving non-committal opinions.

We have had good success with this technic. The non-malignant tumors are readily diagnosed. As a general rule, the carcinomas do not present a problem in diagnosis save for the malignant variant of the pleomorphic adenoma. The sarcomas are recognized as such although their classification as to histologic type may be difficult.

SUMMARY AND CONCLUSION

1. A workable and simple classification of tumors of the salivary glands is presented.

2. A summary of the cases seen by us is presented.

3. Comments about debatable entities are made along with our own conclusions.

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The Position of Radiation Therapy in the Treatment of Tumors of the Salivary Gland

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THE parotid is by far the most common site of tumors of the salivary gland, both benign and malignant. For this reason the discussion to follow will deal with parotid tumors except as indicated. So far as we know, among the tumors of the salivary gland there is no variation in radiosensitivity related to the site of origin. There is, of course, variation with cell type. Also, the ease of delivering a given dose of radiation will vary according to site.

BENIGN MIXED TUMORS

Mixed tumors of the parotid possess certain characteristics which are strongly tempting to the therapeutic radiologist. These tumors are relatively superficial in location and are not anatomically associated with radiosensitive vital structures. Excision of the area is limited because of the proximity of the facial nerve, the ear and the mandible; postoperative recurrences have been frequently reported.

Despite these factors which appear to be favorable for radiation, vigorous radiation as a primary treatment has been tried and found highly ineffective. Doses producing serious changes in soft tissue frequently fail to eradicate the tumor. The reasons for this failure to respond are found in an examination of cell types. As the name implies, benign mixed tumors of the salivary gland are composed of both epithelial and stromal elements. In such tumors we see well developed glands, fibrous tissue, myxomatous stroma, cartilage and, rarely, even bone. None of these elements either alone or in mixture are particularly radiosensitive. Certainly some of these elements may be destroyed by vigorous radiation. The growth rate of others can be decreased. Dense fibrous tissue and vascular changes may "encase" the tumor and very slow growth will result. However, if benign mixed tumors of the parotid were even moderately radiosensitive, surgery would not now play the major role in their management. For this reason even the most enthusiastic therapeutic radiologists agree that the primary treatment of these tumors should be surgery.

The question of postoperative radiation invariably arises. Have we a right to expect any more of radiation after surgery than of radiation given without surgery? I doubt that incomplete surgical removal increases the radiocurability of these tumors. I do not believe incomplete surgical removal plus radiation will produce more controlled patients than complete surgical removal. Such are the arguments which have led most therapeutic radiologists to conclude that even postoperatively the role of radiotherapy is a minor one.

Certain possibilities should not be overlooked in the treatment of benign mixed tumors of the parotid. The normal salivary glands are unavoidably radiated in the treatment of cancer of the oral cavity. Striking changes are produced in these glands. Acinar elements decrease and duct epithelium may become squamous [4]. Fibrosis surrounds the ducts, lobules and acini. Function is arrested. Can radiation producing such changes inhibit further neoplastic degeneration in the salivary gland? Can this decrease the incidence of apparent multiple foci of origin [12]? Is the more actively growing tumor periphery more susceptible to radiation damage than the central bulk of a partially ressected tumor?

These questions remain unanswered. For this reason no one is justified in being dogmatic as to the position of routine postoperative radiation in the treatment of these tumors. In the literature Ahlbom [1], Paterson [10], Bruzelius [3] and McEachen et al. [9] argue that the postoperative recurrence rate is reduced when postoperative radiation is employed. Yet papers like those of Janes [6] record equally low

recurrence rates when no postoperative radiation is employed.

If one follows the surgical recommendations of Janes and removes a layer of apparently normal gland beyond the tumor "capsule," routine postoperative radiation will contribute very little. On the other hand, if one merely attempts to "shell" the tumor out, radiation might reduce the incidence of recurrence or delay its appearance. This philosophy might lead to poor surgery were too much dependency placed on it. However, if tumor is known to have been left behind or if for any reason the patient is inoperable, vigorous radiation with cancerocidal doses seems justified. The aim is that of growth restraint when poor radiosensitivity does not permit eradication.

MALIGNANT TUMORS

Radiotherapy alone and in combination with surgery has been able to control a small number of malignant tumors of the salivary gland. As a primary treatment for malignant tumors, radiotherapy has been applied to selected patients only. This has included the advanced or inoperable lesions. In addition, there have been those in which the surgeon knowingly left tumor behind. The fact that some of these apparently hopeless cases of cancer have been controlled by radiation suggests to us that if modern vigorous radiotherapy were applied to all malignant salivary tumors primarily, a very significant proportion might be controlled. I do not mean to imply that we do this. I only want to emphasize that all is not necessarily lost when surgery is refused or deemed inadvisable. If a patient in good general condition with an apparent localized cancer is referred to the radiologist, radiotherapy should be administered with a curative aim. This may imply intense acute skin and mucosal reactions and the risk of certain late sequelae, but these risks are usually worth taking. Nearly all of the larger recently reported series of cases include some cancers controlled by radiation alone. Still larger numbers are controlled when the surgeon, uncertain of the adequacy of his excision, or having knowingly left tumor behind, recommends postoperative radiation [*5,9*]. McEachen et al. have reported eight patients in whom the disease was apparently controlled by radiation primarily or following inadequate surgery. Such data are so scanty that significant percentages are not available. However, we have only these infrequent experiences on which to base our treatment policy.

If the surgeon and the surgical pathologist agree that the chances are remote that local disease has been left behind, no postoperative radiation is recommended. If it seems probable or certain that local disease has been left behind, vigorous radiation with a curative aim is recommended. Vigorous radiation is also recommended for locally inoperable lesions or for patients who refuse excision. Among the malignant salivary gland tumors, the squamous cell carcinomas and the cylindromas have been found the most radiosensitive [*2*]. While tumors of these cell types are also probably more radiocurable, data on this point are lacking.

I believe the availability of Co^{60} radiations will increase our ability to radiate the salivary gland regions with cancerocidal doses. For tumors of the parotid and submaxillary regions we are usually limited to the use of a single port. The dose given through this port is limited by skin tolerance. With the skin-sparing characteristics of Co^{60} radiations I predict radiotherapy will assume a more effective role in the care of these patients.

Adenocarcinomas arising from the mucosal glands in the paranasal sinuses are of the same general types as described previously. They should be treated by radical surgery when practical [*11*]. However, vigorous radiation (doses of 5,500 to 6,000 r in six to seven weeks) may control some lesions. Tod [*13*] reported on two of nineteen such patients cured by radiation. Larsson and Maartensson [*8*] reported that of twenty-five patients treated for cylindromatous lesions of the paranasal sinuses, nine were well after five years, and two of ten patients with other types of adenocarcinomas were well after five years.

Any of the malignant tumors may metastasize locally or distantly. Worthy of special mention are the metastases from cylindromas which frequently grow very slowly and may produce minimal symptoms. They are surprisingly radiosensitive. We recommend that they be radiated as they appear. Such patients may thus live comfortably many years with their metastases [*2,7*].

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Management of Patients with Far Advanced Cancer of the Head and Neck

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SINCE the beginning of this century, surgery for tumors of the head and neck has been marked by gradual and, at times, spectacular expansion of the scope of the operative procedures. This progress indicates the natural acceptance and utilization by surgeons of antibiotic therapy, greatly improved methods of anesthesia, and better evaluation and preparation of the patient so he is able to withstand the unavoidable trauma of the surgical procedure.

The importance of this phase of surgery is now recognized by those who are engaged in programs of training general surgeons, plastic surgeons, maxillofacial surgeons and otolaryngologists. This, of course, will lead to further improvements in the technic of the operative procedures and one may anticipate that eventually the survival rate will be noticeably increased.

Such expressions as survival rate, salvage rate and five-year cures present a disturbing and a provocative thought, for they are admissions that at least some of the patients treated successfully by surgery will at some time suffer recurrences of the tumor, which will eventually be the direct cause of death.

This presentation deals with patients who may or may not have received surgical treatment or radiation, or both, but are not considered operable and can no longer expect any benefit from radiation. This is not a pretty picture, but the surgeon who undertakes to treat cancer of the head and neck must be prepared to accept the responsibility of total care, either directly or indirectly. If the patient is originally referred to him by another doctor, there should be a complete and honest understanding as to who will render the necessary services after all specific methods of surgery and radiation have been exhausted. As difficult as it may seem, such arrangements should be made in advance with responsible members of the patient's family, who may then be assured of continue[-] treatment and care of the patient when all nope of eradicating and controlling the disease is past.

If the patient is originally referred by another doctor, especially if he is a general practitioner, it is usually understood that the referring doctor will assume the responsibility of long range postoperative care. It is better that a clear understanding is established with the referring doctor as to the needs of the patient, not only in the immediate postoperative care but also in the later phase when the needs will be less specific and more general in nature.

Patients who reach the stage when direct surgical treatment and radiation are no longer deemed beneficial or are inadvisable present needs which are both physical and psychosomatic. Just because a decision has been reached that specific surgical treatment and radiation will not be resorted to does not necessarily mean that supportive surgical procedures are no longer indicated.

Tumor masses about the head and neck may, and usually do, become infected, with formation of abscesses of varying sizes associated with the usual signs and symptoms. These conditions should be recognized early and appropriate treatment instituted promptly. Antibiotic therapy usually controls infection, but when an abscess develops surgical intervention is indicated. Incision and drainage should be performed as soon as the presence of an abscess is established. The choice of anesthesia should be determined by taking into consideration the maximum safety and comfort of the patient.

Enlarging tumor masses producing compres-

sion of the trachea and the esophagus create problems which in all cases should be individualized. As a rule, tube feeding of the patient can be maintained for a long time in spite of the compression of the esophagus by a tumor mass. Obstruction of the pharynx, layrnx or trachea requires prompt and sometimes emergency treatment. The surgeon must decide whether the mass causing the obstruction or compression is removable, or if tracheostomy should be the method of choice.

Technically, tracheostomy is a much easier procedure, is less traumatic to the patient and eventually may be the last resort to let the patient breathe. However, tracheostomy must be considered as a very potent factor in separating the patient from his environment by eliminating or curtailing his communication with others by the use of his speech. I do not intend to minimize the value and importance of tracheostomy. However, I would like to stress the importance of postponing this procedure for as long as possible and exploring the possibility of relieving the obstructive symptoms by removal of tumor masses, even though only temporary benefits can be expected.

Bleeding from an ulcerated tumor mass is always a challenging problem, and usually occurs in far advanced cases. Hemorrhage from such a lesion is alarming and dramatic and, if not controlled, results in a quick and painless death. Where possible, ligation of vessels supplying the tumor should be performed. Depriving the tumor of an adequate vascular supply produces a diminution of pain, a shrinkage of the tumor volume in some instances, and a marked improvement in the patient's general attitude. Of course, these benefits are only temporary. Except in very unusual circumstances, maintaining the life of a patient with uncontrollable bleeding by giving multiple blood transfusions is open to serious moral criticism. Religious and ethical opinions are in agreement that a physician is not obligated to maintain life by such artificial methods when no reasonable means are available to arrest the bleeding definitely.

Because of the dynamic character of tumor growth, and as a result of destructive surgery and radiation in the region of the head and neck, there occur complications which interfere with normal function and unfavorably influence the patient's welfare.

CASE REPORTS

CASE I. Mrs. M. A., a fifty year old white woman, was treated with intensive x-ray therapy in a university hospital for an inoperable adenocarcinoma at the base of the tongue. At the time of her presentation, there was no obstruction to respiration or swallowing. As a result of the uncontrolled growth of tumor and also possibly due to the radiation effect on the lymphatics, the anterior two-thirds of the tongue gradually increased in size, filling the entire oral cavity and eventually spilling out between the teeth. Chewing became impossible, salivation was distressing and the odor was repulsive. She used a surgical mask at all times.

Examination revealed extensive stony infiltration of both sides of the neck and the floor of the mouth. Examination of the mouth and pharynx was impossible. She sustained herself on a liquid diet, and in general felt well enough to perform the usual duties of a housewife. It was apparent, of course, that eradication of the tumor by surgical means could not be effected. Supportive therapy, including tranquilizing drugs, was instituted but the size and protrusion of the tongue became extremely disturbing to the patient and her family. A sufficient portion of the tongue was simply amputated to allow her to close the teeth and lips. This relatively simple procedure allowed her to be accepted again by those near her, and changed her general outlook very favorably. She died seven months later of a hemorrhage.

CASE II. A forty-six year old man had been operated upon two years previously in a university hospital of a neighboring state. A diagnosis of neurosarcoma was made, and the left maxilla and the contents of the left orbit were removed. He received intensive radiation therapy and it was believed that the tumor originated in the left optic nerve. He was free from the disease for about eighteen months, when there was a recurrence of the tumor in the deepest portion of the orbital cavity. He was given intensive radiation therapy again, but the tumor failed to respond. He was informed that nothing more could be done for him, and was discharged. The tumor grew, and finally nearly filled the orbital cavity. With the remaining good eye the patient was able to observe the gradual increase in size of the tumor. When he presented, he was despondent and discouraged but said that something should be done for him. Examination revealed a granulation-like mass nearly filling the left orbit. As a result of the surgery and the heavy radiation, he also had a fibrous ankylosis of the left temporomandibular joint. His inability to open the jaw limited his diet to liquids and very soft food, and markedly contributed to his general ill-being. His physical

discomfort was real enough but his mental attitude was, by far, more serious. He felt rejected and discarded, and condemned to die because "nothing more could be done." He expressed himself clearly; he believed he could not expect to be cured, but bitterly resented the thought that he could not be helped.

With the patient under endotracheal anesthesia, part of the tumor was resected for microscopic study and the remainder was electrocoagulated down to the optic foramen. The mandible was transected at the angle. Immediate postoperative motion of the mandible resulted in a good pseudarthrosis, allowing good function of the mandible. It was difficult to evaluate the patient's reaction when he no longer saw the tumor in his socket, but his parting statement was significant. He pleaded that he should never be denied help when he asked for it. Since his initial operative procedure the tumor has been cauterized every four to six months.

COMMENTS

These two cases are presented only to emphasize the multiphasic needs of patients with tumors of the head and neck. It seems unnecessary to mention such well known facts that patients with inoperable tumors should not be allowed to suffer pain. Mood-ameliorating drugs and tranquilizers have a very important role in the medical management of these patients.

There is a peculiar attitude of some people toward the use of narcotics, probably influenced by the fear that continued use of such drugs will lead to addiction. This is true, but the fear of addiction in patients whose life expectancy is measured in days or weeks is hardly justifiable. When all hope of cure is gone it is only humane on the part of the doctor to prescribe such drugs, and in sufficient amounts to make the patient free from pain at all times. I use the word humane, but perhaps I should have stated that it is the duty of the doctor to alleviate pain by any means at his command.

There may be some patients who cannot be controlled by medication and perhaps a neurosurgical procedure may be indicated. These, however, are very rare instances. Certainly, before a patient is subjected to such procedures it is understood that all other methods of controlling pain have failed.

Medical hypnosis has been used with considerable success in controlling anxiety and pain in patients with far advanced cancer. I believe that in such instances hypnosis perhaps would be of great benefit to the patient. Such patients know that all hope is gone for them, but they always maintain that tenacious desire to live and therefore are open to suggestion. By the use of hypnosis it was possible to reduce the administration of narcotics to a minimum.

Specific painful areas about the region of the head and neck may at times be controlled by blocking the peripheral nerves, either with a local anesthetic or by alcohol.

CONCLUSIONS

Patients with far advanced cancer of the region of the head and neck present problems which may be at least temporarily improved by judicious surgical and medical treatment. Physicians who undertake surgery on tumors of the head and neck must accept the responsibility of giving total care to the patient with far advanced, inoperable or recurrent cancer. When all hope of care is past, there still remains the duty of the physician to make the patient comfortable by the application of sound surgical and medical means.

Neurological Evaluation of the Patient with Craniocerebral Injury

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THERE can be no rigid rules for the management of the patient with severe injuries to the head and face. His problem must be viewed in its entirety. Initially, steps should be taken so that the person will maintain the vital functions of respiration and avoid shock. Treatment, observation and evaluation should proceed simultaneously. In the present day, because of the nature of our transportation and its occasional consequences, injuries are frequently multiple, involving the face, head, neck, extremities and internal organs. Therefore, rules of precedence cannot be adhered to blindly and all systems must be under our observation.

STATE OF CONSCIOUSNESS

When the physician first sees the injured person, he should determine whether he is dazed, stuporous or comatose, so that he will be aware of the direction of subsequent states of consciousness. If the patient can understand and answer questions readily there is no acute intracranial emergency. If he fails to respond to oral communication, response from painful stimulation of pinprick or firm pressure over the supraorbital notch will give a clue to the state of consciousness. Repeated observations by the same person are valuable. A regression in the state of consciousness speaks for an increase in intracranial pressure and calls for close observation of vital signs. If consciousness is maintained or coma is lessening there has been little neural damage. Observation of vital signs should include the pulse, blood pressure, respiration and temperature.

A progressive lowering of the pulse accompanied by a paradoxical rise of the blood pressure should alert one to the possibility of intracranial hypertension. However, it should be kept in mind that a distended bladder may cause irritability and a rise in blood pressure.

The rate and character of the respirations constitute a reliable guide to the extent of injury to the central nervous system. Slow, deep breathing and irregular respirations indicate a grave prognosis. Respirations below 10 per minute speak for increased intracranial pressure but one must be certain that there is not an obstruction in the respiratory tree. Frequently the air passages are obstructed by blood, mucus or vomitus. This can be avoided by positioning the patient on his side; it is important to turn him from side to side to permit proper drainage of the respiratory tree. Rapid, shallow breathing does not indicate intracranial hypertension. It may result from encroachment upon the airway or trauma to the chest.

Early hyperthermia, not arising from infection, is proportional to the severity of the injury to the brain. The hypothalamus is vulnerable to trauma and hyperthermia frequently results. The hyperthermia of central origin is constantly high and not as intermittent or spiking as that which results from infection.

The pupils should be observed as to size and reaction to light. The presence of fixed dilated pupils is invariably an ominous sign. Bilateral constriction and fixation of the pupils suggest involvement of the mid-brain. One should know whether or not the patient has had morphine which also constricts the pupils. Unilateral dilatation of the pupil with no reaction to light is caused by compression of the third nerve from herniation of the medial aspect of the temporal lobe over the edge of the tentorium. Unilateral dilatation of the pupil is spoken of as a classic sign of a subdural or extradural hematoma on the same side. Such is often the case but a hematoma may be present without there being a dilated pupil, and a dilated pupil may occur

from other causes such as cerebral edema. The dilated pupil may be present on the side opposite the hematoma.

PARALYSIS

Immediate hemiparesis usually occurs with severe local cerebral contusion. Paralysis occurring hours later should suggest the development of a hematoma. The paralysis is flaccid in its early stages. The deeper the stupor, the more difficult it is to detect the paresis. In the stuporous patient one should observe the comparative response to pinprick on the two sides of the body. In a comatose patient all that one may see is a relaxation on one side of the face on expiration.

REFLEXES

Total areflexia usually indicates profound coma, and is an ominous sign. In the early stages of hemiplegia, there are decreased deep tendon reflexes on the involved side of the body. Pathological reflexes, particularly the Babinski sign, are indicative of cerebral damage.

CRANIAL NERVE PALSIES

Occasionally, with severe injuries to the face, fractures may radiate to involve the base of the skull. In these instances, cranial nerve injuries, particularly of the optic, oculomotor, adbucens, facial and acoustic nerves, may result.

SPINAL INJURIES

The immediate recognition of a spinal injury is important in order to prevent further damage to the spinal cord. This is not difficult in the conscious patient but is difficult in the comatose patient. Diaphragmatic respiration and the absence of reflexes in the lower extremities should suggest involvement of the spinal cord. The failure to obtain any movement in response to painful stimulation in the lower portion of the body, when it is present in the upper part of the body, indicates involvement of the spinal cord. Further proof may be obtained by performing a lumbar puncture with the Queckenstedt maneuver and obtaining x-rays films of the spinal column.

ROENTGENOLOGIC EXAMINATION

As a general principle, roentgen examination is not an aid in the early neurologic evaluation of the patient with severe injuries to the face. Not only is it better for the patient to lie undisturbed in bed but also the quality of the films obtained under difficult circumstances makes the effort expended unfruitful.

Lumbar punctures are of little value either for determining the degree of pressure or localizing the anatomic origin of the increase in pressure regardless of the etiology. In severe injuries, the finding of blood in the cerebrospinal fluid does not prove that the blood is arising in the subarachnoid space. Reducing the pressure by lumbar puncture has only a temporary effect and may be dangerous, for one may precipitate herniation of the temporal lobe into the incisura of the tentorium.

INTRACRANIAL HEMORRHAGE

Extradural hemorrhage is a craniocerebral condition which requires immediate surgical care if one is to avoid a fatality or marked neurologic deficits. The hemorrhage arises from a torn middle meningeal artery or perhaps a dural sinus. The classic syndrome consists of a lucid interval followed by deepening stupor. The pulse becomes slow, blood pressure rises and respiration becomes slow and labored. The ipsilateral pupil may become dilated. The contralateral extremities may be paretic. If treatment is delayed, signs of decerebrate rigidity appear and death ensues.

A subdural hematoma may, in rare instances, progress as rapidly as an extradural hematoma, and the signs of the two may be indistinguishable. However, subdural hematomas are usually slow in formation. The bleeding ordinarily arises from one of the bridging cortical veins extending from the cortex to the sagittal sinus. Even though there may be localizing signs they are frequently bilateral. Surgical evacuation of the hematoma is indicated if there is a regression in the state of consciousness or if the vital signs and neurologic findings suggest this diagnosis.

Subarachnoid hemorrhage is frequent in severe craniocerebral injuries. The symptoms occur after the first day following the injury. The presence of blood in the cerebrospinal fluid causes nuchal rigidity, headache, fever and irritability. Conservative care is the proper initial regimen but later there may be signs of an intracranial aneurysm or arteriovenous fistula.

Intracerebral hemorrhage may occur when there is a cerebral contusion or laceration. Such a situation is fraught with danger and is difficult

to differentiate from the other types of hemorrhages mentioned. If there are adequate localizing signs, evacuation of the hematoma may be life-saving.

Braunstein [1] has stated that of all injured persons studied, injury to the head was sustained most frequently (72.3 per cent). Injuries to the lower extremities were the second most frequent injuries noted (47 per cent) and the ones most commonly found in combination with injury to the head (22.7 per cent). Over one-third of the skeletal injuries were femoral fractures, the tibia and fibula being affected about as frequently. This combination of craniocerebral injury with fractures of the long bones serves to complicate the diagnosis and management of these patients because of the possibility of fat emboli occurring in patients with fractures of the long bones.

Love and Stryker [2] have recently reported on fat embolism, and the similarity of its signs to those of craniocerebral injury is apparent. The most likely source is the fatty marrow of a fractured long bone of an adult. If the fat cell is ruptured so as to release liquid-free fat, increased pressure may force it into the torn veins of the vicinity. This is all the more likely to occur in the patient who has been transported long distances without proper immobilization of the fractured extremity.

The patient usually displays a lucid interval following the injury but it can occur in a patient who has a concomitant craniocerebral injury and is unconscious. Cyanosis appears and the respiratory rate increases. The initial period of restlessness may progress to delerium and coma. Some have observed a fall in the hemoglobin accompanied by a rise in blood pressure on the first day. On the second and third day fine brownish petechiae appear over the upper part of the trunk, especially in the axillas. It is a very important diagnostic point and one which should be searched for in patients whose state of consciousness is regressing. Current therapy includes intravenous infusions of 5 per cent glucose-5 per cent alcohol for its emulsifying action. Oxygen and 25 mg. of heparin daily are also suggested.

Observation of the patient's neurologic signs to determine the presence of increased intracranial pressure need not delay definitive care of the accompanying extracranial injury. In fact, there is no substitute for prompt attention in obtaining immediate comfort and a good end result.

If cerebrospinal rhinorrhea or otorrhea exists, the prophylactic use of sulfadiazine or Gantrisin® may prevent meningitis or other intracranial infection. Irrigation is to be avoided so that infection is not introduced. Closure of a cerebrospinal fistula can be aided by a 45 degree elevation of the headrest which permits the brain to rest on the site of egress of the fluid.

Prompt débridement and meticulous suture of lacerations of the scalp and face will result in comfort and a better cosmetic appearance. One should not hesitate to shave an appropriate area of the scalp. Initial surgical cleanliness should be practiced. If it is not, disaster may result should it be necessary to enter the calvarium later to deal with an intracranial complication. Prompt and adequate reduction of fracture of the facial bones can usually be performed with very little anesthesia. This will result in less pain and reduce the need for analgesic medication, a point of great concern in the patient with increased intracranial pressure. The proper reduction of a facial fracture may improve the airway and thus permit better oxygenation. In some instances it may even facilitate closure of a cerebrospinal fistula. Permanent facial deformity, as would result from a floating maxilla, may be avoided.

The early treatment of the associated injuries will not preclude proper observation and treatment of craniocerebral injury. It is justifiable for the reconstruction it permits, but, in addition, it will facilitate a reduction in discomfort, infection, the period of hospitalization and recovery from the more severe intracranial injury which may be present.

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Electrical Burns of the Mouth

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"LIVE electrically," says little Bill. This is a popular slogan on billboard signs and television programs. Ever since we have had electricity it has performed miracles in human life. On the other hand, electrical hazards are multiple and have resulted in acute disasters. The ones with which we are confronted in this paper are electrical burns of the mouth.

Electrical burns of the mouth probably occur most frequently and are limited to the younger generation. As soon as babies are allowed to crawl this hazard becomes manifest. The inherent tendency to place everything in the mouth and chew on it is the primary cause. This chewing continues until a direct short is established between the two wires, which causes a flash burn from the arcing and also a surge of current to pass through the tissues producing many changes. These range from a mild hyperemia to a black char, depending on the length of time the current is on, direction of the flow of current, amperage, voltage and the ground. Needless to say, these babies are thrown into shock and should be treated immediately.

Enough thought and action has not been given to this danger to date. An electrical code should make it obligatory to have the following specifications set up: (1) All lamp cords should be made of a heavy solid rubber covering that will not break down on being chewed by a baby. (2) All wall and lamp plugs should be operated by a master switch on the wall so all cords and plugs are devoid of current when this switch is open. (3) All wall plugs should be about 3 feet from the floor and of a type that a baby or small child could not operate. These three factors would contribute valuably toward preventing catastrophies.

The treatment for burns of the mouth, in some respects, is a great deal more simple than that of intensive body burns. The voluminous dressings with pressure or other methods of therapy are not the treatment of choice here.

The most important factors in the treatment of burns of the mouth are (1) control of pain, (2) prevention of shock, (3) reduction of infection to a minimum, (4) active treatment of the denuded area to promote growth of granulation tissue and (5) plastic repair of skin, muscle and mucous membrane at the proper time.

Burns which destroy the vestibule of the upper or lower jaw and cheek sometimes can be corrected immediately by placing a split-skin graft over a stent of modeling compound or acrylic resin and joining it in place. This, however, can be done only in older and more cooperative patients. Burns in babies must be allowed to heal and correction made subsequently.

The typical electrical burn in babies destroys the corner of the mouth, involving the skin, muscle and mucous membrane. This type of burn should be allowed to heal. Very often 50 per cent or more of the orifice of the oral cavity will be destroyed. When this wound has healed, it will be found that much of the body of the lip in that region has become fibrotic due to the surge of current through the tissues. Every effort should be made to conserve this tissue to reduce the deformity. Frequently it can be utilized in the reconstruction and, by proper preparation of flaps and suturing, a good cosmetic result can be obtained. Often one finds that one-half or more of the upper and lower lips has been destroyed and, in healing, the oral cavity has become occluded completely, except for perhaps a small opening about the size of a lead pencil. These deformities should be corrected by making horizontal incisions in the

cheeks, being sure to balance the openings on each side. Elevating skin and mucous membrane surfaces and approximating them will effect a good correction. The skin and mucous membrane at the corners of the newly formed mouth should be well undermined so that the corner of the mouth is thin and has a normal appearance. If this is not done, the corners of the mouth are too heavy and do not look normal, resulting in more contraction and narrowing of the orifice. When a narrow band of dense fibrous tissue develops in the process of healing, it is sometimes advisable to remove it, providing it does not produce a deformity. Simple incision will result in less formation of scar tissue and less deformity.

Discrepancies in the lip tissue (when it is lost or there is too much), causing an irregularity in the vermilion border or in the mucocutaneous junction, can be corrected by the typical V-Y plasty. Several of these transpositions will be necessary to correct these badly burned mouths. Destruction of large masses of tissue can be corrected by only one method, the pedicle tube. This method must be resorted to whenever the occasion demands in spite of its disadvantages. The additional scarring, lack of innervation and motion, and difference in color index all must be overlooked.

The currently used antibiotic drugs (penicillin, Aureomycin,® Terramycin® and others) surely have lightened the burden of treatment and shortened the course of invalidism. These drugs reduce the infections to an absolute minimum and allow granulations to form quickly.

Much can be done to effect a quicker postoperative recovery to normal by the addition of massage of burned tissues. This stimulation brings about early relaxation, enhanced blood supply, normal draping of tissue, destruction of fibrous connective tissue and normal response on nerve impulse. Surely this phase of treatment should not be overlooked.

The nutrition factor should have some consideration in these patients. In most cases a bland, liquid or semi-soft diet will be in order. This can be taken by mouth, and in some cases with a glass tube or straw. In the more severe cases a Levin tube or indwelling catheter passed through the nose should be resorted to. This type of feeding may help greatly in preventing many complications that might otherwise arise due to a fluid imbalance, infection or disturbance of grafts.

In conclusion, we proclaim that many of these electrical accidents can be prevented by better education of consumers, chiefly in some of the simple principles of physics, mechanics and chemistry, which should be taught to all high school students and to students in teacher-training institutions.

Treatment of Acute Thermal Burns of the Face

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DUE to its exposed, unprotected location, the face is commonly subjected to thermal injuries from scalds, flames and hot objects. Initially the depth of burning is dependent upon the intensity, duration and location of the heat. Many injuries from flames and burns from hot objects involve the entire thickness of skin, and in some instances deeper structures are destroyed. Infection and mechanical and chemical irritation may convert a superficial burn into a whole-thickness burn. The objectives of the early care of a local wound are to avoid infection and to achieve healing as soon as possible. Regardless of the depth of injury, if these early aims are not accomplished, the problems of reconstruction are compounded.

Scalds and burns from flames about the head and neck may be associated with burns of other areas of the body, particularly the hands. Burns from flames about the face and neck are frequently complicated by damage to the upper respiratory tract, and inhalation of irritating vapors or fumes may injure the lower respiratory tract. These complications may be life-threatening and demand early tracheotomy. In civilian practice the child under five is a frequent victim of scalds from hot liquids. Older children may sustain deep burns about the face and neck if clothing is aflame and the victim runs. Many of these childhood accidents could be prevented by continued emphasis upon the importance of employing safety measures in the home and by the use of non-flammable fabrics for children's clothing and party costumes. Flash burns of the face and hands occur commonly in industry, the home and military life. Some of the deepest facial burns have been recorded in airmen and tank crews during combat. In these instances the victim is usually entrapped within an inferno, and if escape is possible the severe surface burns of the exposed areas are frequently complicated by injury to the respiratory tract. Deep contact burns of the face are commonly sustained by persons who fall into a fire or against hot objects during an epileptiform seizure.

In extensive burns about the head and neck, marked edema occurs within a few hours after injury. Eyelids close early because of swelling, and the patient may be panic-stricken from the fear of loss of vision if he has not been forewarned that swelling will seal the eyelids. The formation of edema about the face and neck reaches its maximum about forty-eight hours following the burn. Disorientation and extreme apprehension are commonly observed in the patient with extensive facial burns. As in other areas of the body, it is difficult to assess the depth of the acute burn accurately. There is no reliable method to judge the difference clinically between a superficial second degree or deep dermal burn in the acute phase. Third degree burns are usually white or charred, and the surface is anesthetic to pinprick. A history of the accident usually offers some clue to the probable depth of the burn. When multiple areas of the body are deeply burned, the face, neck, hands and areas about the joints should receive priority for skin closure with autogenous grafts as soon as possible.

IMMEDIATE GENERAL CARE

Facial burns are such obvious injuries that those inexperienced in the management of acute trauma may forget to evaluate the entire situation. A history of the injury and a rapid but systematic physical examination may often detect a more serious or life-threatening condition other than the obvious wound. The

severity of thermal trauma is dependent upon the extent of the body surface involved and the depth of the burn. Burn shock usually occurs if more than 15 per cent of the body surface is burned; however, this phenomenon should be anticipated in patients with extensive burns about the head and neck even though the total burned area is less than 10 per cent of the body surface.

The first problem in burns about the head and neck is to determine the adequacy of the airway. Injury to the respiratory tract is suspected by a history of inhalation of irritating hot vapors, fumes or flames. When the victim of a burn is first attended by a physician, the signs and symptoms of respiratory obstruction may be present, and immediate tracheotomy is indicated. Labored respirations, coughing, hoarseness, cyanosis and air hunger should offer sufficient warning of impending suffocation. Intraoral examination reveals redness and pharyngeal swelling. Increasing edema of the larynx and glottis may completely obstruct the passages of the upper respiratory tract. It should be remembered that damage to the lower respiratory tract occurs in some patients, and early aspiration of rapidly accumulating bronchial secretions through a tracheotomy may be necessary to prevent "wet lung." Despite a lack of evidence of irritation of the respiratory tract, early tracheotomy should be strongly considered as a prophylactic measure in the management of patients with whole-thickness burns about the face and neck. Elective tracheotomy before massive edema of the neck occurs has its merits.

If burn shock is present or can be anticipated, an intravenous infusion of an electrolyte solution should be started to maintain a venous pathway for the administration of colloids if necessary. A cutdown and catheterization of a peripheral vein should be performed. Oral fluids should be given with caution in the extensively burned patient complaining of thirst because vomiting and ileus are common during severe shock. The primary physiological defect in burn shock is an ineffective circulating blood volume due to loss of plasma, electrolytes and destruction of red blood cells. Thirst is an early symptom of shock and, if present, is best controlled by intravenous replacement therapy. If unrestricted oral fluids are allowed, vomiting is common and leads rapidly to severe electrolyte imbalance. With vomiting there is the danger of aspiration of gastric contents into the respiratory passages. Although the Evans and Brooke General formulas may be of value in estimating the amounts of colloids and electrolytes which may be needed, the amounts and the rapidity of administering intravenous infusions are determined by correlating the patient's urinary output and his clinical response to the replacement. An hourly output of 20 to 50 mm. of urine coupled with abeyance of the symptoms of shock indicates a favorable response to replacement therapy. If little or no hourly urinary volume is attained, the rate of infusion of colloids and electrolytes should be increased.

An increase in the output of urine beyond 50 mm. per hour should warn of the possibility of impending pulmonary edema, and fluid therapy should be curtailed. The proper management of burn shock requires constant vigilance and alteration of therapy when indicated by a continually changing course of events. Shock may be a problem for as long as forty-eight hours after the thermal injury.

Pain is seldom a major complaint following the initial thermal insult, but should be alleviated when present. If burn shock and pain occur simultaneously, an intravenous injection of a small amount of morphine or Demerol® may be indicated to insure prompt relief of pain. Repeated subcutaneous injections of narcotics do not help those in severe shock and often lead to acute poisoning from the rapid absorption of accumulated doses into the blood stream where the peripheral circulation improves after fluid replacement therapy. Disorientation, a common manifestation of shock, frequently is misinterpreted as pain. Extreme apprehension may be lessened by the judicious use of sedatives or narcotics administered by a route which insures rapid action.

Prophylaxis against tetanus should be given to all patients with deep burns. Tetanus toxoid boosters afford protection for those who have been actively immunized. In non-immunized persons, at least 3,000 units of tetanus antitoxin should be given following a test for sensitivity to the foreign serum. For those with deep and extensive burns of the body, intravenous antibiotic therapy is advisable during the first three days.

Burns from flame and scalds seldom cause direct serious injuries to the cornea and sclera because of the lid reflex. The prompt instillation

of an antibiotic ophthalmic ointment may help to avoid infection in burns about the eye. Consultation with an ophthalmologist should be a part of the immediate care if damage to the eye is suspected or evident after examination.

INITIAL CARE OF THE BURNED SURFACE

The initial local care of the burned surface is directed toward avoiding infection. As soon as the patient's general condition permits, the burned area should be gently cleansed. If the burn involves the hairline, the adjacent hair should be closely clipped.

Cleansing is done with soap, or a mild detergent, and sterile water. Every effort is taken to carry out the strictest aseptic precautions. The eyes are covered with sterile moist cotton sponges to prevent irritation of the conjunctiva and cornea. After cleansing with soap and cotton pads, the area is rinsed with sterile water or saline. Another sterile set-up with gloves, tissue forceps and scissors is used for trimming vesicles, loose tags and removing other debris. The face and neck are then left exposed.

It is difficult to apply a satisfactory dressing in facial burns. Experience has shown that the exposure method is the method of choice following the initial cleansing and toilet for burns. The local applications of ointments or medications should be avoided if the exposure method is used, for the purpose of the method is to allow drying of the wound. Facial dressings are difficult to apply and will not prevent the massive edema following the burn. An improperly applied dressing leads only to maceration and mechanical trauma of the surface of the burn, and infection may rapidly follow. A tight or constricting dressing may lead to serious complications such as local areas of pressure necrosis or mechanical obstruction of the airway.

LATER CARE OF THE BURNED SURFACE

The exudate of the partial-thickness burn dries within the first two days and forms a protective crust on the surface. Although it forms a mask which may be uncomfortable, the overlying crust protects the regenerating epithelium. If infection, maceration with ointments and mechanial irritation are avoided, superficial second degree burns heal without scarring in two weeks.

Deeper partial-thickness injuries, or the "deep dermal" burns, are a greater problem. The overlying crust is thicker, and the time required for spontaneous healing is much longer. Healing may take as long as five weeks and scarring is invariably present. Deep dermal burns may easily be converted into whole-thickness injuries because of infection.

Little or no superficial exudate occurs following a whole-thickness burn, and the devitalized skin changes its color and configuration during the first week. This dry, discolored surface is called an "eschar" which is depressed beneath the level of surrounding areas of normal skin or partial-thickness burns. Because of the great vascularity of the face, eschars start to soften and separate at the edges about seven to ten days after the burn was incurred. When this stage is reached the original eschar no longer serves as a protective barrier against bacterial invasion. It is necessary to avoid further contamination of the open wound from this time until complete coverage of the skin has been achieved because of the danger of an invasive infection. Sterile, moist dressings are applied to hasten the separation of the dead tissue from the underlying vascular surface.

Formal surgical excision of facial eschars is neither necessary nor advisable because of two factors: (1) the natural rapidity of separation of the whole-thickness slough and (2) a needless sacrifice of underlying subcutaneous or deeper tissues entailed by the procedure. Frequently, however, scissors can be used to divide tough avascular strands between the necrotic skin and the deeper tissue. When spontaneous separation of the slough begins, the application of daily moist dressings and bloodless removal of dead tissues will convert a dirty wound into a surgically clean wound within five to ten days. Failure to evacuate purulent or serous accumulations beneath the softened eschars can result in a burrowing type of local infection which deepens the injury. Granulation tissue forms rapidly about the face, and in most cases the burned surface will be clean and vascularized well within three weeks following the injury. In practice, local applications of antibiotics do not seem to hasten preparation of the wound surface for grafting. Infection, local or invasive seldom occurs unless breaks in aseptic technic or failure to provide adequate drainage of the contaminated wound has occurred. A single layer of fine-meshed gauze should be placed

on granulating surfaces to facilitate its removal without tearing the tissues. Ointments and grease dressings frequently macerate the wounds and adjacent areas, and block drainage.

In small localized burns, the surgeon may hasten healing with less deformity by deliberate conversion of a deep dermal burn into a full-thickness loss, which can accept a skin graft. One must remember that all granulating surfaces are contaminated but not necessarily infected. Split-thickness skin grafts will survive on contaminated surfaces, but if applied to infected areas the result is disastrous.

COVERAGE OF WHOLE-THICKNESS BURNS

In most patients skin grafting is possible within three weeks after burning, and every effort should be made to shorten this interval. Only split-thickness skin grafts can be used to cover granulating wounds. Full-thickness grafts are reserved only for reconstructive procedures when the burns are well healed. The primary objective in the management of whole-thickness burns is to obtain healing as early as possible with minimal loss of function and disfigurement. Later reconstructive procedures can often be anticipated from the earliest phases because of the depth and location of the burns. The ultimate restoration of function or appearance is enhanced by an early closure of the original injury.

The donor areas for procuring partial-thickness grafts will depend upon the regions which are available. For localized burns there is no problem regarding the choice of many varied donor sites, but in extensively burned patients donor areas may be sparse and may have to be reused to obtain several successive crops of skin in order to achieve permanent healing. In adults split grafts from 0.012 to 0.020 inch in depth are used to cover granulating wounds, but in infants and young children the grafts should be thinner to insure prompt healing of the donor surface and a satisfactory take of the graft upon the surface of the burn. If the donor area is irregular due to bony prominences one may inject isotonic saline solution into the subcutaneous tissues to round out the contour.

With proper care the donor area should heal as rapidly as a superficial second degree burn. Infection, and mechanical and chemical irritation have to be prevented. Rayon may be used to cover the raw surface followed by an overlying compression dressing. Frequently the outer dressings are removed to the single thickness of rayon after forty-eight hours to avoid maceration. This technic is quite similar in principle to the exposure method for superficial burns. Donor areas should be healed within nine to fourteen days.

It is advisable to estimate the amount of skin required to cover the burns prior to procuring the grafts. One method is to cut patterns of the raw surfaces and to calculate the total area from the pattern.

After the skin has been removed it should be protected against drying by keeping it lightly moistened with isotonic saline solution. The grafts are carefully spread onto the granulating surfaces. Suturing of the graft to adjacent skin borders is helpful in maintaining good apposition. Stent dressings are useful in difficult areas. In some patients no dressing over the graft is necessary, and this technic has been used with success in covering burns of the perineum, buttocks and wall of the chest.

Improper dressing technics may jeopardize the skin grafts due to maceration, constriction or slippage. A properly applied dressing consists of multiple layers which later can be removed without disturbing the grafts. Fine-meshed gauze or rayon can be used as the initial layer, followed by moistened gauze squares. Dry fluffed gauze held in place by abdominal pads serves to complete the dressing which is held in place with gauze rolls or woven elastic bandages.

The eyelids should be covered with grafts as soon as the eschar is removed. Tarsorrhaphy should be performed at the time of grafting to prevent ectropion. The objective in the treatment of burns about the eyes is to prevent corneal damage with its subsequent ulceration. Whole-thickness burns of the ears frequently result in necrosis of the cartilage. Devitalized cartilage should be removed before liquefaction and abscess formation occur.

In some patients with multiple granulating areas about the scalp, face and neck, the skin grafts may be procured and refrigerated for twenty-four to forty-eight hours. These preserved autografts can then be applied to the irregular areas without the use of general anesthesia. This is no more difficult than applying a dressing, and the patient usually has no more discomfort than a change of dressings would cause. The surgeon or his associates

should check the integrity of dressings several times each day. Within four to five days the dressings are changed since secretion at the borders of the defect may undermine the grafts. If coverage has been complete, the dressings may be discontinued after two weeks.

GENERAL SUPPORTIVE CARE

Throughout all phases of management the nutritional status of the patient has a direct relation to the healing of the wounds, skin grafts and donor sites. Following the period of burn shock the severely burned patient should be placed on a high protein, high calorie diet. Supplementary feedings of high protein formulas may be introduced through a plastic nasogastric tube if the patient is unable to take the required amounts orally.

Plasma and other forms of intravenous proteins are of no value in helping to correct protein deficiency. Daily diets containing 2 to 3 gm. of protein per kg. of body weight and 3,000 to 5,000 calories may be necessary to maintain satisfactory nutrition of the extensively burned patient. Vitamin C is necessary in amounts up to 1.5 gm. per day, and other vitamins are given in therapeutic doses. Severe secondary anemia is characteristic in extensive deep burns an should be combatted by frequent blood transfusions.

Systemic antibiotic therapy is recommended prophylactically for extensive deep burns because of the common occurrence of invasive infection. We seldom rely upon the use of local antibiotics during any phase of management of the burned patient. If infection becomes a problem, wound cultures and bacterial sensitivity tests will lead to the proper choice of the antibiotic agent for systemic use.

SUMMARY

The objectives of the early care of burns about the face are to avoid infection and obtain healing as soon as possible. Initial treatment is facilitated by use of the exposure method. In extensive burns, shock and irritation of the respiratory tract are frequent complications which necessitate early aggressive care. Emergency tracheotomy may be necessary to relieve obstruction of the upper respiratory tract and to alleviate damage to the bronchopulmonary system. For those with extensive full-thickness burns about the face and neck, early tracheotomy is a valuable adjunct to management. Full-thickness losses in the face and neck should receive a high priority for early autogenous skin coverage. Although surgical excision is widely advocated for other areas of the body, it is not applicable for the face. However, most deep burns of this region can be prepared for split-thickness skin grafting within three weeks following injury.

Failure to accomplish this objective leads to stubborn infection, increased deformity and disfigurement, and the problems faced during further reconstruction may be compounded or at times are insurmountable.

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Chemical Burns

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ACCIDENTAL contact with chemicals, or their misuse, is prominent among the causes of injury and death, and constitutes one of the potential hazards of our modern life. It has been pointed out [1] that there are about 25,000 chemical products now available for use in the home, industry and agriculture, and approximately 3,300 deaths a year result from misuse of these chemicals. This does not take into account the many thousands of serious but non-fatal accidents, as only deaths from these causes are recorded in the vital statistics. Likewise, these figures pertain to chemicals for civilian use and do not include the war gases and other forms of chemical agents now available, or being developed for use in warfare, nor the accidental deaths therefrom.

Chemical accidents give rise to various superficial and systemic reactions of many degrees, dependent upon the strength, amount, concentration, degree of penetrability and mode of action of the chemical agent, and the manner and duration of contact. The resulting effects include burns, stricture from corrosion, perforation of organs by penetration of the chemical, respiratory irritation, asphyxiation, systemic intoxication, and deleterious reactions in the gastrointestinal and nervous systems, the kidneys, liver and other organs.

This presentation will be confined to a discussion of chemical burns, and limited to those of the face, eyes, mouth, nose, throat and esophagus. However, because of the differential in significant etiology, characteristic action, pathologic changes and some phases of treatment between burns and corrosive injuries from the organic compounds, inorganic oxidizing agents, alkaloidal reagents and certain gaseous substances and vapors, and those resulting from the war gases *per se*, the two groups will be discussed separately.

To submit herein a complete or comprehensive list of chemicals which potentiate or cause serious burn injuries from misuse or accidental contact would be infeasible, but included are the mineral acids and alkalis, basic salts and gases. Within these categories are the corrosives which destroy protoplasm at the point of contact, many inducing systemic toxicity. In this connection, the tendency in industry has been to use increasing amounts of metallic and non-metallic salts. This has been largely responsible for a greater risk of chemical burns.

PHYSIOLOGIC EFFECTS OF CHEMICALS IN BURNS

The chief difference between chemical burns and those resulting from other causes is that the destructive process occasioned by chemical burns continues until the effect of the cauterizing agent is neutralized. Characteristically, chemicals differ in action. Some produce systemic lesions without evidence of injury at the port of entry. With other chemicals, such as the corrosives and some of the gas irritants, there is apparent injury at the port of entry with remote or systemic evidence of direct injury. The local pathologic lesion may cause acute vasal collapse, or may be the factor immediately responsible for death. Still other chemicals produce both local and systemic evidence of injury. As a matter of fact, the physiologic effects of some chemicals may be reflected by myriad disturbances in a single or any combination of many functional systems, and in the nature and distribution of pathologic lesions.

The concentration of chemicals in locations where they enter or leave the body is a factor of major importance, as in those pathologic lesions produced in the gastrointestinal and respiratory tracts, and kidneys. Petri [2] discussed another common effect of many chemicals, i.e., their deleterious hepatotoxic action.

He stated that concentration of the chemical agent may take place because of the position of the liver and the portal circulation, the specific metabolism of the organ in its attempt at detoxification, or because of excretion into the biliary system. Likewise, the entrance and/or direct inhalation of many irritants into the pulmonary circulation may give rise to rapidly fatal pulmonary edema because of the vulnerability of alveolar capillaries.

In injuries attributable to the mineral acids and alkalis, the common factor responsible for trauma is the H or OH concentration, respectively. According to Freidenwald et al. [3], irreversible alteration will occur if the pH is below 2.5 or above 11.5. Other factors responsible for corrosive injury include coagulation, precipitation, dehydration or actual solution of protein. Furthermore, acids are known to produce coagulation necrosis; alkalis, colliquative necrosis. According to Lecgaard [4], presumably since alkaline proteinates are soluble, it is possible for the OH ion to pass successively fron one molecule to another, denaturing each in turn, without becoming immediately inactivated. He stated, on the other hand, that the H seems to be neutralized immediately at the point of contact.

PATHOLOGY

It is well known that burns from acid chemicals may be extremely destructive, and their effect is immediately apparent. Conversely, it has been found that alkali burns are deceptive; at first their effect may appear slight but they progress seriously by direct extension. For this reason they are often insidious. Alkalis produce lesions which are usually softer and more edematous. With increase in the survival time, the lytic effect of the digestive enzymes and the development of secondary bacterial infection make the differential diagnosis progressively more difficult. When death from alkali burns is rapid, the superficial mucosal necrosis of the lesion, bordered on its submucosal aspect by hyperemia and edema, may be all that is seen. Later, extension of this zone of necrosis may progress to the submucosa, depending upon the extent to which the cellular components have undergone irreversible injury. Secondary thrombosis may add to the damage. Leukocytes gradually accumulate at the base of the lesion incident to their disintegration. The released enzyme leads to liquefaction and finally to sloughing away of the necrotic material.

In the pathology of chemical burns of the eye alkalis cause swelling of the skin surface of the conjunctiva and cornea, and these then become soft and jelly-like. The alkali penetrates rapidly and tends to combine with the tissue, so that even long-continued irrigation of the eye does not remove all of it. According to Ryan [5], some of the alkalis have been detected in the aqueous fluid of a rabbit's eye within a few minutes after being placed on the cornea.

After ingestion of a corrosive agent there may be rapid circulatory collapse, shock, severe corrosion of the oral cavity, pharynx and esophagus, perforation of the stomach and intestines, and/or rapid death. Massive malacia of the stomach or lower portion of the esophagus may represent a postmortem artifact. One of the most common complications here is cicatrizing esophagostenosis. Repair may be followed by the formation of dents and vascular scar tissue, and stricture formation of the esophagus is a common sequela to such scar formation. Incomplete regeneration of the epithelium over the cicatrix of a chemical injury may lead to chronic ulceration, and the laying down of fibrin on the injured surface may lead to fibrinous membranes.

According to Stumhoff [6], the pathologic changes in the stomach are striking. He pointed out that upon receiving the corrosive chemical the stomach is forced to contract sharply, thereby limiting the initial necrotizing effect to the eminences of the rugae. Stimulation of still intact glands at the depths of the fold leads to the outpouring mucus which covers the surface. This could pertain to any exposed mucous membrane subjected or exposed to a corrosive chemical agent.

The appearance of the necrotic mucosa may serve to identify the responsible offending corrosive. For example, sulfuric acid characteristically blackens and chars the tissue; phenol leaves a firm, thick, moderately dry, dull gray or brown eschar; hydrochloric acid leaves a white to gray-brown discoloration; nitric acid may show a yellow component because of the xanthoprotein induced by the action of concentrated nitric acid on protein.

In burns from corrosive chemicals, injury, especially acute laryngeal and pulmonary edema, may follow aspiration, particularly if the corrosive agent is volatile.

CAUSAL FACTORS AND EFFECTS

It would seem axiomatic, yet worthy of comment, that in chemical burns, as in few other accidental injuries, the etiology would be, and is, distinctly interrelated with the type of chemical agent, its mode of action and the character of the accidental misuse of, or contact with, the chemical. Many types of chemical accidents occur and many have been reported. With the human element involved, still others are potential and can be anticipated. Some corrosive chemical agents are ingested accidentally because they are mistaken for some harmless substance. Such a chemical is oxalic acid, frequently ingested by mistake because of its physical resemblance to magnesium sulfate. Oxalic acid is a crystalline, colorless, odorless substance, having a local irritating action on the skin and mucous membrane, and causing gangrenous ulceration. In addition to its cauterizing effect, the systemic toxicity resulting from this agent, according to Jeghers and Murphy [7], is caused by removal of calcium ions from tissue fluid incident to formation of insoluble calcium oxalate, reflected clinically by mild to severe manifestations of hypocalcemia. According to Dunn et al. [8], delayed death from oxalic acid may be caused by injury to the kidney. They stated that concentration of oxalic acid at the port of excretion may lead to degeneration and necrosis of the tubular epithelium of the kidney.

Hydrofluoric acid is a highly corrosive substance, and is a liquid at relatively cool temperatures. In addition to reacting immediately with the tissues, anhydrous hydrofluoric acid will continue to destroy tissue until it has been removed. This acid is also systemically toxic. Flack and Scofield [9] pointed out that spilling of concentrated hydrofluoric acid upon the skin may lead to an injury that is extremely slow in healing, owing in part to ischemic necrosis from intense local vasoconstriction produced at the site of contact.

Phenol is not only a skin irritant but also a local anesthetic, so that burns from this agent may not be felt until serious damage is done. It can also be absorbed by the skin and appear in the urine, to which it imparts a smoky color. In delayed death from phenol burns, the urine may be smoky and aromatic because of oxidized phenol derivatives. In superficial burns from phenol the characteristic dull gray color is caused by the coagulating action of phenol on the proteins of the skin. When this substance is left on the skin for a long time it can cause a black gangrene. Therefore, when phenol comes in contact with the skin it should be washed off immediately with ethyl alcohol and oil dressings applied.

Phenol, as well as some of the other organic corrosives, are excellent fixatives. For this reason, in burns resulting from ingestion of these agents, there may be remarkably little microscopic alteration in chemically killed mucosal cells. A splashing of phenol upon the unbroken skin has been reported by Hamilton [10] to have caused rapid collapse and death, apparently owing to depression of the central nervous system. Postmortem findings in such instances are insignificant, however.

After ingestion of formaldehyde the esophagus and stomach may become shrunken, gray, and somewhat tough and inelastic. In delayed death from this agent the mucosa may be converted into a friable eschar. Inhalation of the vapor of formaldehyde gives rise to irritation of the upper respiratory tract.

The characteristic lesions produced by chromic acid are "chromholes." These lesions are very deceptive, and usually have the appearance of small darkish spots surrounded by a peeled area with a center ring that is the outer border of the "chromhole." Pus is usually found in these holes, the walls of which are tissue undergoing necrobiosis. One of the important points is that the lesions are usually painless because the chromic acid produces a local anesthetic effect on the involved tissue, and the wounds may become third degree burns before the patient feels pain.

Acetic acid is one of the strongest organic acids and has the property to penetrate the tissues readily, causing dermatitis and ulcers. The fumes of this acid cause irritation of the mucous membrane.

Formic acid is a colorless liquid with a pungent odor, and is irritating to the mucous membrane. It will produce blisters on the skin which tend to spread, forming new ones even after exposure ceases. The vapors of formic acid will char paper, are inflammable, and may explode when mixed with air and ignited.

Corrosive effects of the group of alkaloidal reagents are caused by ability of the anion to direct chemical precipitation of protein via the

anion. Chief among these alkaloidal reagents are the trichloroacetic, tungstic, picric, sulfosalicylic, phosphomalybdic and tannic acids. Of these, the two compounds most important from the practical standpoint are tannic and picric acids.

Tannic acid and its effect upon the liver was discussed by Wells et al. [*11*] and Hartman and Romence [*12*]. It was pointed out that hepatic injury may follow absorption of tannic acid applied at the site of a cutaneous burn. Furthermore, tannic acid hepatic necrosis has been produced by subcutaneous, intraperitoneal and intravenous injection of the acid. As to the effects of picric acid, Colhuquon [*13*] stated that mild systemic toxicity, after cutaneous absorption, has been attributed to this agent. According to Dennie et al. [*14*], the compound has been shown to be nephropathic. It was reported by Harris et al. [*15*] that in nearly all of a ship's crew symptomatic hematuria developed after the water supply had been contaminated by picric acid.

Accidental burns from lye are frequently reported from ingestion of the substance, particularly by children, and from other forms of contact. According to the reports, the esophagus is the most frequent site of burns and corrosion resulting from ingestion of lye. Injuries from hot tar are also frequently observed. Likewise, there are reports of bronchial constriction and other injuries from industrial and agricultural handling of chemicals, such as the organic phosphates contained in insecticides and the inorganic arsenics contained in wallpapers and paints.

In addition to these, there are reports of injuries resulting from accidental spraying of the body and face with hot grease or fuel oil used in grease guns. These guns are used by mechanics and others for spraying lubricating grease and lubricating and diesel fuel oils at pressures ranging from 1,000 to 7,000 pounds per square inch. Noble and Thuss [*16*] reported the case of a patient who was struck in the eye by lubricating grease from a high pressure grease gun. They stated that grease or fuel oil has been found to penetrate skin from distances of 8 inches or more, and that a large quantity can enter the skin in an instant without causing a grossly evident break in the skin. The authors stated that "In contrast to the purer long chain hydrocarbons, lubricating grease and diesel fuel oils produce immediate chemical irritation in the tissues, with marked swelling, local heat, and redness."

Chemical injury caused by gaseous substances and other atmospheric contaminants may occur locally at the site of initial contact with the skin and mucous membrane, or systemically after absorption. The individual compounds comprising the poisonous gas group may exist in the atmosphere of true gases and vapors emanating from liquids, solids or liquid droplets. Noxious gases and vapors may be classified according to their toxic action: irritants, asphyxiants and systemic intoxicants.

Pulmonary irritants are encountered in many occupations. They injure particularly areas with a moist surface favoring a solution and localization of a chemical agent. Tissues respond to any irritating gas, and massive exposure may lead to direct necrosis and ulceration. However, the concentration of the irritant is rarely of sufficient high magnitude to accomplish this type of direct injury. Usually, because of the extreme pollution of the irritant-the initial sign of injury is reactive hyperemia and edema, and later diapedesis and leukocytic infiltration. The clinical and pathologic manifestations of exposure to an irritating gas depend upon where the respiratory tract undergoes greatest injury. The factors determining this selectivity of action are not clear, but are dependent in part upon the ready solubility of the gas in water and in part upon the rapidity of chemical reactivity of the irritant with body tissue.

Although there is obviously a good deal of overlapping, Henderson and Haggard [*17*] recognized three groups of gaseous irritants. One of these is described as the group affecting the nose, eyes and pharynx, the acute symptoms of which constitute a warning signal of exposure but are rarely fatal. Nevertheless, after excessive exposure there may be necrotizing pharyngitis or tracheobronchitis. There is frequent ulceration and sloughing of the mucosal epithelium, and the underlying tissue becomes edematous, hemorrhagic and infiltrated by leukocytes and fibrin.

The second group consists of those gaseous substances principally affecting the trachea and larger intrapulmonary air passages. It might be expected that inhalation of irritant gases and fumes would predispose to secondary infection of the respiratory tract, but this is likely only when exposure has been heavy. Statistically,

according to Baitzer [18], there seems to be no increase in respiratory infections incident to prolonged exposure to low concentrations of air contaminated by the halogen acids (the non-metallic elements), such as chlorine, iodine, bromine, fluorine, sulphur and nitrogen dioxide, acrolein, oxide of nitrogen and others.

The first symptoms may be those of mild coryza. After a period of several hours, subsequent development of air hunger points to involvement of the deeper respiratory structures. If death occurs in the first twelve to twenty-four hours, there is usually evidence of associated hemorrhagic edema in the centrally located pulmonary lobules. The pathogenesis is dependent upon differences in the susceptibility of the bronchial and alveolar epithelium to injury. Gas concentration inadequate to cause serious damage to bronchiolar mucosa may still be sufficiently high to cause injury to the more delicate endothelium of the alveolar capillaries. Thus concentration at the site of the centrally located alveolar ducts and communicating alveoli which have the shortest, most direct connections with the bronchi and hilus may lead to rapidly fatal edema. In addition, focal patches of atelectasis, emphysema and early bronchial pneumonia may develop within the first twelve to twenty-four hours.

The third group of gases classified by Henderson and Haggard are those principally affecting the pulmonary parenchyma, and include the oxides of nitrogen and phosgene incorporated in the list of war gases, which will subsequently be discussed.

Still other chemical gases include arsine (arsenous hydride), an acute hemolytic poisonous gas, produced whenever an acid reacts with a crude metal. Hunter [19] has pointed out that there is usually a latent period of several hours before manifestations of the acute hemolytic reactions appear. Death may occur acutely or may be delayed for several days, incident to the development of progressively increasing renal insufficiency. Another highly toxic gas is hydrogen sulfide, evolved when organic material decomposes, and a main component of sewer gas. Locally, hydrogen sulfide is necrotizing to the lining of the upper respiratory passages.

EMERGENCY TREATMENT

In the treatment of chemical burns immediately after an accident, the first steps are directed toward decontamination by irrigation, dilution and neutralization of the causative agent. Thorough irrigation of the burned area with large quantities of water should be done immediately to accomplish dilution of the chemical agent. It should be emphasized, however, that neutralizing a caustic chemical before it has been thoroughly diluted is not justifiable. This is because, inherently, the heat generated in the neutralization process may in itself be sufficient to cause a burn.

Next, a neutralizing agent, specific for the particular offending chemical, is applied to the burn lesion. In an acid burn a neutralizing agent of weak alkali, such as a solution of bicarbonate of soda, ½ ounce to 1 pint of water, is indicated; in an alkali burn, dilute acids, such as a 1 per cent solution of citric acid. In my experience with patients having chemical burns during World War II, the Korean conflict and in private practice, I have used hydrocarbons with caution for this purpose. Care must be taken to avoid use of a neutralizing agent in such strength as to cause further injury to already damaged tissues.

In burns from simple solvents, irrigation of the burn lesion for ten minutes or more is usually adequate. However, in burns from stronger and more potent chemicals, both acid and alkali, irrigation should be continued for at least thirty minutes or more. After the chemical agent has been removed by neutralization, the injured area should again be washed with copious amounts of water to carry away any heat of the neutralizing agent before it can damage the tissues.

In burns resulting from some of the stronger acids, as in the case of hydrofluoric acid, the most effective first aid measure is the prolonged application of very large quantities of tepid water to flush the highly potent chemical from contaminated skin and reduce the injury. The skin, after contact with hydrofluoric acid, has a peculiar marble appearance, but after prolonged washing with water the burned area assumes a natural pinkish color, an indication that sufficient flushing has been accomplished. In removing anhydrous hydrofluoric acid, it has been found necessary to apply water for a period of three to five hours for the average burn, and in the case of very severe burns, for a total period of nearly twelve hours. If pain is not experienced immediately on contact with hydrofluoric acid, and in some cases it does not occur

until several hours later, a person receiving burns at work may go home without being aware he has been burned.

When the exposed mucous membranes of the nose, mouth and adjacent areas have been burned with a chemical, the parts are covered with an application of a bland ointment after irrigation and neutralization of the chemical agent.

In the case of a perforated nasal septum resulting from a chemical injury, the best effort is toward prevention, because it is very seldom possible to get the patient to the medical department before sloughing has advanced to the point where perforation will follow. Application of cotton, carrying some neutralizing agent, such as ethylene-diamine tetra-acetic acid, harmless to the mucous membranes, followed by a bland oil, may afford some protection.

Because of the very nature of injuries from chemicals, no specific therapy has been demonstrated to be of significant value. However, from experience and as the result of trial and error, certain counteracting and emollient substances have been found efficient in the early alleviation of discomfort from chemical burns and the cleansing of the burn lesion. For example, it has been recommended [*20*] that the best solvent for removing hot tar from burned skin is sterile mineral oil, followed by gentle cleansing of the area with soap and water and the usual occlusion dressing. In burns from oxalic acid, for instance, injection of a calcium salt at the site of the local lesion may partially negate the deleterious effect.

Care of chemical burns of the eyes takes priority over all else. The reason for this is obvious. As Haik [*21*] cautioned, chemical burns of the eyes demand immediate emergency treatment by the medical personnel available, but whenever possible the patient should be transferred to an ophthalmologist as quickly as feasible for continued specialized therapy and possible surgery.

The first step in the emergency care of chemical burns of the eyes is *copious* irrigation with water, keeping the eyelids open to allow the water to irrigate all areas of the eye. Germane to this procedure, a report of the Committee on Industrial Ophthalmology of the A. M. A. Council on Industrial Health [*22*] noted the great saving of eyesight among industrial workers by immediate and thorough flushing of harmful chemicals from the eyes by copious irrigation with water. Furthermore, the report pointed out that "Published reports of research in the use of buffered neutralizing solutions have failed to show superiority of buffer instillation over proper water irrigation. Buffer action is essentially limited to neutralization of acid and alkaline substances. Water irrigation removes chemicals by mechanical flushing."

To avoid synechia of the iris in chemical burns of the eyes, it is important to keep the pupils dilated. Instillation of cocaine for control of pain is often called for, but local anesthetics should not be continued. Furthermore, instillation of warm vaseline or other lubricant ointments and frequent moving of the eyelids will prevent them from adhering to the eyeball, and will avoid the sticking together of denuded surfaces. In addition, an antibiotic should be instilled into the burned eye to prevent secondary infection. Bal® ointment (2,3-dimercaptopropanol) has been found of value, and hydrocortisone or cortisone given locally are often efficient anti-inflammatory agents in treating burn lesions of the eye.

The patient who has ingested a caustic chemical and incurred burns of the mouth, throat and esophagus is given milk and olive oil by mouth as quickly as possible after the accident and later at frequent intervals. It is of vital importance that the patient burned by ingestion of a corrosive be hospitalized immediately, as the earlier treatment can be instituted, the better the chances of recovery. This is of particular importance in burns of the esophagus, where delay enhances the possibility of complicating esophageal stricture and stenosis.

Emergency treatment of the patient burned by a gaseous substance depends upon the type of gas, its corrosive and irritant potency, its tendency to necrosis, its toxic or systemic effects, and its manner of induction or entry. In addition, depending upon the location of concentration of the gaseous substance and the area affected, emergency measures such as artificial respiration, administration of a stimulant and other procedures specific for the conditions existing may be required.

SUBSEQUENT MANAGEMENT OF CHEMICAL BURNS

The next phase in the management of chemical burns, after the initial care, follows closely

the treatment indicated for thermal burns. However, in the case of burns of the face and eyes, and those of exposed mucous membranes of the nose, mouth, throat and esophagus, treatment is understandably specialized. Because of the special sense organs in or about the face and the disfigurement inherent in a burn lesion, management of facial burns is of especial significance. This, of course, is not restricted to chemical burns.

During the maintenance period in the treatment of the severely burned patient, antibiotics, often the broad-spectrum variety, are frequently given. Cortisone therapy has also been advocated. Some authors [*23–25*] recommend combined antibiotic and steroid therapy for the chemically burned patient. Nevertheless, some side effects have been reported with the use of cortisone, such as hypoadrenocorticalism, and measures have been advanced to prevent or overcome some of these complications by a decrease in cortisone dosage, and for replacement of deficiencies, such as potassium loss from continued cortisone therapy.

In burns resulting from some of the very strong acids and alkalis, palliative measures are entirely ineffective. The proper treatment in such cases is excision of the entire area of tissue undergoing necrosis. If pus is present, and if the resulting excised wound is antiseptically treated and antibiotics are employed, rapid healing usually follows.

As stated previously, treatment of the patient with chemical burns follows largely that used for thermal burns. Likewise, definitive treatment and plastic repair of the burn lesion, with few exceptions, is the same as that for other types of burns. Therefore, for a comprehensive discussion of these procedures, describing the open method of treating the burn lesion, and definitive repair and reconstruction, the reader is referred to three of my previous articles [*26–28*].

WAR GASES AND OTHER CHEMICALS USED IN WARFARE

It was thought that in a paper devoted to chemical burns, a short inclusion of some of the various chemical warfare agents would be of connotative interest. These compounds consist of true gases, volatile liquids or solids which disperse upon explosion. They were generally available during World War II and the Korean conflict, and include those which act largely as local irritants and corrosives, and which combine systemic and toxic effects in addition to their serious burning power. The following list of war chemicals and gases is, understandably, not a complete one, owing to the constant development of new chemical weapons.

Tear gases or lacrimators
- Chloroacetophenone
- Bromobenzylcyanide

Sternutators
- Diphenylchlorarsine
- Diphenylaminearsine chloride (adamsite)

Lung irritants
- Chlorine
- Phosgene (carbonyl chloride)
- Chloropicrin (trichloronitromethane)
- Sulfur
- Acrolein
- Nitrogen dioxide

Vesicants
- Chlorovinyldichloroarsine (lewisite)
- Dichlorodiethyl sulfide (mustard gas)

Nerve gases
- Organic phosphates: Tetraethylpyrophosphate and others

Miscellaneous
- Screening smokes: White phosphorus
- Mixtures: Sulfur trioxide-chlorosulfuric acid
  Titanium and tetrachloride
- Incendiaries: Thermit®
  Magnesium and its alloy
  White phosphorus

Others
- Petroleum oil smokes
- Hydrocyanic acid
- Napalm

PATHOLOGY AND TREATMENT

The fatal and non-fatal effects of the war gases and chemicals are manifold, and vary with each type. Summarized, they include affection of the nervous system, such as the parasympathetic nerves, endings of motor nerves and the central nervous system; irritation and constriction of the lining of the respiratory tract and lower bronchial tree; asphyxiation; systemic toxicity by absorption; degeneration of blood-forming organs; poisoning; inflammation; anemia; redness, burning, blistering and necrosis of the skin at point of contact; destruction of mucous membranes; and pain. The intensity of the symptomatology

and effect is dependent upon the concentration of the gases and other of the war chemicals at the time of exposure.

White phosphorus, when in contact with the skin long enough to burn, produces a gray discoloration, and the initial pain is severe. Phosphorous acids generate and tend to penetrate more deeply. Blisters are rare, but the burns separate more than other burns and heal slowly over a period of three or four weeks. Scars are usually thin. White phosphorus is extremely poisonous and the vapors are dangerous. According to Chretien [*29*], and Rubitsky and Myerson [*30*], large doses may lead to death by depression of the central nervous system, preceded by coma, convulsions and finally by medullary paralysis. In delayed poisoning the principal clinical disturbances are referable to hepatic damage.

Phosphorus burns should be treated by irrigation of the injured part with water. If immersion of the burned part is not possible, the burn lesion should be covered with wet compresses, since water prevents acceleration of the burning by phosphorus. While the burned part is covered with water, the particles of phosphorus should be removed with gauze-covered forceps. The area should be washed with a dilute solution of sodium bicarbonate, after which a 1 per cent solution of copper sulfate should be applied. Copper sulfate produces a dark coating of copper phosphide on the residual particles of phosphorus. These dark particles can be recognized easily and removed. Blocker [*31*] noted that this procedure was used in the treatment of phosphorus burns which occurred during the Korean conflict.

Dichlorodiethyl sulfide (mustard gas) is the best known of the vesicants. It is a transparent, amber-colored, oily liquid, and was called mustard gas by British and American military forces because of its characteristic color. It can penetrate and produce serious burns of the skin, and is very persistent in its effect. The vapors are toxic even when inhaled in minute quantities. One or two hours after exposure, severe conjunctivitis, burning of the skin which goes on to blistering and necrosis, and vomiting develop. Mustard gas is insidious in its action. The first systemic symptoms appear two to six hours after exposure, depending upon the concentration. The higher the concentration, the shorter the later periods.

Skin lesions caused by mustard gas reach their maximum intensity forty-eight hours after exposure, and then begin to abate. The lesions begin with erythema which shortly develops into vesiculation. The vesicles soon break down forming more or less deep ulcers, depending upon the amount of mustard gas to which the skin has been exposed.

For the burns of mustard gas or to prevent further burning, first aid, to be effective, should be applied within the first three minutes after exposure. It consists of washing the part with kerosene or gasoline to dissolve the mustard gas, then washing in a strong solution of soap and hot water to remove the kerosene or gasoline and the mustard. The part should be rubbed dry and then rinsed with cool, clear water. Injuries produced by mustard gas heal very slowly and therefore are potential targets for infection.

Lewisite acts more quickly than mustard gas. When a drop of lewisite is placed on the skin, redness begins to appear at the end of thirty minutes; it appears only after two hours with mustard gas. Vesiculation appears at the end of thirteen hours with lewisite, while it takes four hours for vesicles to appear with mustard gas. Thirty drops of lewisite allowed to remain on the skin of a man weighing 150 pounds produce fatal results. The minimum irritating concentration of lewisite is .0008 mg. per L. and the minimum lethal concentration is .120 per L. for ten minutes. Bal (2,3-dimercaptopropanol) is used in the treatment of local and systemic actions resulting from lewisite and some other vesicant war gases, and was developed during World War II as an effective agent for this purpose.

The organic phosphates referred to as nerve gases are, according to Wood [*32,33*], much more toxic than formerly known agents such as the mustard gases.

Magnesium burns are usually small and produce an enlarging ulcerative type of injury unless all the metal is removed. The ulcerated area must be curetted down to viable tissue under local anesthesia. A neutralizing agent is of no value.

COMMENTS

A greater insight into the physiology of burns, appreciation of the important changes in fluid and electrolyte balance in the severely burned patient, and the development of supportive and antibiotic drug therapy have eliminated

many of the complications and reduced the mortality previously associated with severe burns. Nevertheless, these advantages have, to some extent, nullified themselves. Today our problems with the severely burned patient are complex. First, although many burn lesions are amenable to advanced methods of plastic surgery and restoration, we may see more unavoidable deformities and facial blemishes because of the reduced mortality. Second, there is now the prolonged period of maintenance, and continued and prolonged drug therapy for the severely burned patient who, according to Steiss et al. [*34*], "formerly would have been no problem at all, since he would not have survived the initial stage of his injury."

This drug therapy, using specific and sometimes potent drugs (particularly the broad-spectrum antibiotics), while of great benefit to the severely burned patient, has implications of side reactions which have proved to be serious from observation and clinical investigation. For this reason, Steiss et al. stated that experience in the treatment of severe burns and complications resulting therefrom "has caused us to have an even greater respect for the potentialities of the antibiotics, and to refrain from their prophylactic use over prolonged periods, and to reserve their great potential benefit for specific situations indicated whenever possible by sensitivity tests."

While great strides have been made in burn therapy, Dr. Patrick Clarkson of Guy's Hospital, London, at a meeting of the Basingstoke Plastic Center Medical Society [*35*], expressed the need for developments in the treatment of the severely burned patient. He stated that these should be based upon a more complete knowledge of the enzyme chemistry and electrolytic and colloid exchanges in the early stages after burning, and of the metabolic and endocrine factors. At the same meeting Professor R. H. Thompson, also of Guy's Hospital, discussed the role of enzymes in local and general effects in burns. He stated that "There may be abnormal local cell metabolism because of the inactivation of enzymes by heat, and active enzymes might be released into the general circulation from damaged cells. Redness and blistering may result from selective enzyme inhibition by a chemical factor. This can be seen in the action of lewisite, which inhibits cell oxidation systems and which can be reversed by dimercaprol. The thermal sensitivities of skin enzymes vary greatly, and in a burned area conditions are present that may cause selective enzyme inhibition. The part played by enzyme systems released from burnt tissue is not certain. Proteinase liberated outside the cell may possibly produce vasodilatation and loosening of the epidermis."

SUMMARY

A discussion of chemical burns of the face, eyes, throat and esophagus from misuse of or accidental contact with chemicals is presented.

The several classifications of chemical agents, as presented, include the mineral acids and alkalis, alkaloidal reagents, certain gaseous substances, and the war gases and other chemicals used in warfare. The characteristics of each type and the mode of action are discussed.

The effects and resulting pathologic disorders of chemical burns are described.

Emergency care is outlined and subsequent management of the chemically burned patient is discussed. It is emphasized that the promptness and thoroughness with which decontamination, irrigation, dilution and neutralization of the offending chemical are accomplished after the accident is of primary importance in relieving the effects of the chemical agent, and in preventing further burning and corrosion from continued chemical action upon the tissues.

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Book Reviews

Tracheotomy: A Clinical and Experimental Study. By Thomas G. Nelson, M.D. William & Wilkins Co. Baltimore, 1958. *Price* $3.75.

This book should be of interest to specialists who perform tracheotomy frequently. The book is too detailed and too complete to interest most general practitioners.

The title, "Tracheotomy: A Clinical and Experimental Study," is somewhat misleading because there is no new material in the book. The experimental study refers to clinical experiences more than research experiences.

The list of references is excellent. The drawings and photographs are good and the language is clear.

WILLIAM SAUNDERS, M.D.

Diseases of the Esophagus. By J. Terracol, Professor of the Faculty of Medicine of Montpellier, France, and Richard H. Sweet, M.D., Associate Clinical Professor of Surgery, Harvard Medical School, Boston, Mass. 682 pages, 408 illustrations, 4 in color. W. B. Saunders Co. Philadelphia, 1958. *Price* $20.00.

This is the first complete and authoritative presentation of a subject which in the past ten years has attained its rightful place in surgery. Based on the second edition of Terracol's "Les Maladies de l'Esophage" published in 1951, the American author has performed a superb task in translating the original French work, in deleting controversial material and in bringing it up-to-date by adding to it the results of his own extensive surgical experience. This comprehensive treatise on esophageal diseases will be of inestimable value not only to the endoscopist and thoracic surgeon but also to the internist and general surgeon.

The first portion of the book deals with the anatomy and physiology of the esophagus in a concise manner. The presentation of the blood supply, venous and lymphatic drainage as well as enervation of the esophagus is particularly good. Esophagoscopic and radiologic examinations of the normal esophagus are well discussed, and both diagnostic aids are again presented in relation to the various medical and surgical disorders of the esophagus in subsequent chapters. The portion of the book dealing with foreign bodies and treatment of cicatricial stenosis are based on the extensive experience of the French author. There is an excellent chapter on esophageal substitutions by skin tube, stomach, jejunum and colon. The authors' condemnation of the application of various foreign body prostheses certainly is appropriate. The pessimism of the physician dealing with carcinoma of the esophagus is dispelled by the results of the senior author, who has had a 20 per cent survival in patients with cervical carcinoma, 23 per cent in patients with carcinoma of the mid-thoracic segment and 32 per cent in patients with carcinoma of the lower esophagus in his "curative resections." The palliation obtained by resection of the carcinoma and re-establishment of continuity of the esophagus has given lasting relief to a large number of additional patients.

The illustrations are superb throughout and are pertinent to the presented material. The surgical corrections of the various disorders are well illustrated by diagrams and descriptions. Statistics of the results of surgical treatment of various esophageal lesions are included. A valuable appendix consists of lists of various diets for patients with dysphagia due to obstruction.

The extensive bibliography taken from the 1950 edition of "Les Maladies de l'Esophage" has been included together with the pertinent bibliography of the past eight years. We agree with the senior author that no such comprehensive listing can be found elsewhere in convenient form. The bibliography is a valuable addition to this book.

The peak of development of esophageal surgery has been reached in the past ten years and little will be added in the near future. The authors should be congratulated for their foresight in bringing this book to publication at this time.

KARL P. KLASSEN, M.D.

AUTHOR INDEX AND SUBJECT INDEX
VOLUME 98

Author Index, Volume 98

Abramson, D. J., 730
Adams, B. E., 248
Adams, R. M., 248
Al-Naaman, Y. D., 735
Ashley, F. L., 217

Badame, J. M., 756
Badgley, C. E., 432
Baker, J. W., 304
Barnes, N., 116
Baron, H., 34
Bartels, W. W., 760
Beal, J. M., 584
Beattie, A. S., 236
Beavis, J. O., 816
Bell, J. L., 923
Bennett, G. E., 484
Bergin, W. F., 612
Berne, C. J., 1
Bhadkamkar, A. R., 107
Bhatt, V. P., 107
Borkenhagen, R., 796
Bowers, W. F., 664
Briggs, N. M., 196
Brizzolara, L. G., 753
Bromberg, B. E., 880
Bronsther, B., 603
Brown, N., 631
Bullen, B., 343

Carter, J. G., 91
Carter, R., 175, 271
Chambers, F. W., 830
Clayton, M. L., 373
Cloward, R. B., 722
Cohn, R., 296
Cole, W. H., 544
Connell, J. F., Jr., 31, 685
Coon, W. W., 4
Cooper, T. J., 623
Craig, T. V., 775
Crane, J., 290
Cressman, R. D., 202
Crystal, D. K., 265
Curry, G. J., 517, 530

Dale, W. A., 20
Dalitsch, W. W., 869
Davila, J. C., 9
Davis, J. B., 91
Davis, N., 91
Day, S. W., 265
De Lorenzo, A. G., 555
DeVito, R. V., 657
DeVoe, A. G., 384
Duncan, J. A., 229
Dunn, F. S., 821
Dunphy, J. E., 55
Dye, E. R., 368

Echeverría, E., 695
Ecker, H. A., 826
Edwards, J. W., 217
Eitzen, O., 750
Erich, J. B., 677

Farris, J. M., 236
Felder, M. E., 95
Foote, J. A., 4
Frackelton, W. H., 390
Friedman, M., 211

Gadboys, H. L., 9
Gallagher, J. R., 332
Garcia, E. N., 217
George, R. E., 664
Georgiade, N. G., 783
Gerber, M. L., 598
Getzen, L. C., 598
Glover, R. P., 9
Goin, J. M., 290
Goldman, L., 283
Gordon, C. A., 41
Gordon, E. T., 105
Gordon, R. E., 41
Gowing, D., 55
Graham, J., 116
Green, B. E., Jr., 706
Grillo, E. B., 34
Grisolia, A., 760

Hagland, L. A., 746
Hall, D. P., 128, 646, 779
Hampton, O. P., Jr., 534
Harkins, H. N., 657
Harkness, J. T., 328
Hawley, P. R., 519
Hayes, J. T., 432
Head, M., 875
Hewlett, T. H., 664
Hibner, R., 296
Hill, L. D., 304
Hinds, E. C., 787
Hinshaw, D. B., 175, 271
Hodgson, P. E., 4
Hoffman, E., 99
Holderman, W. D., 593
Hood, L. T., 91
Housepian, E. M., 733

Jackson, J. L., 664
Jackson, P. P., 184
Jacob, S. W., 55
James, L. R., 91
Jamplis, R. W., 202
Jergesen, F., 136
Joergenson, E. J., 175
Johnston, C. G., 566
Jordan, P. H., Jr., 612

Kalani, H. L., 750
Kapp, R. W., 750
Kavanagh, F. J., 363
Keast, R. W., 506
Kelley, H. G., Jr., 772
Klaus, R. L., 887
Kostrubala, J. G., 915
Kowal, R., 796
Kragh, L. V., 677
Kraus, H., 353
Kuhli, R., 559

La Sorte, A. F., 631
Lane, S. L., 904
Leddy, W., 243
Leeds, S. E., 211
Levi, A. A., 739
Lewis, G. K., 928
Lewis, J. J., 12
Lichtor, A., 683
Lichtor, J., 683
Listerud, M. B., 657
Lobb, A. W., 265
Lochman, D. J., 847
Loe, R. H., 160
Loewy, A., 844
Loomis, J. W., 223
Lymberopoulos, P., 683
Lyon, C. G., 283
Lyttle, S. N., 530

Author Index

MacDonald, J. L., 243
Madding, G. F., 276
Maggs, R. L., 111
Masters, F. W., 887
Mayer, J., 343
Mayfield, F. H., 577
Mazur, M., 628
McCorkle, H. J., 290
McCown, I. A., 509
McKain, J. M., 756
McLaughlin, H. L., 539
McLenathen, C. W., 165
McNall, E. G., 217
Meckstroth, C. V., 126
Meftah, M., 728
Mehnert, J. H., 743
Merendino, K. A., 657
Meyer, A. C., 653
Mitchell, J. H., 805
Mock, C. J., 44
Moran, J. M., 584
Morgenstern, L., 628
Moritz, J. R., 493
Morse, H. N., 120, 635, 762
Moseley, H. F., 401
Moss, W. T., 912
Muller, W. H., Jr., 651
Murphey, F., 379

Nadal, J. W., 190
Najarian, J. S., 290
Nelson, S. W., 122, 642, 764, 768
Nohlgren, J. E., 223
Nordstrom, N., Jr., 784
Nyhus, L. M., 657

O'Connell, T. F., 257
O'Donoghue, D. H., 463
Olivares, J., 695
Olson, H. H., 196
Orban, B. J., 809
Owsley, J. Q., 290

Palumbo, L. T., 702
Panagopoulos, A. P., 898
Patterson, H. A., 12
Patton, R., 447
Pitts, H. H., 184
Price, W. G., 753
Putong, P., 907

Quigley, T. B., 315, 477

Rachun, A., 363
Rauch, R. F., 637
Ravdin, I. S., 583
Rawlinson, K., 337
Reinus, F. Z., 111
Reno, J. H., 451
Reynolds, B., 713
Roberts, J. M., 223
Roberts, M., 713
Robinson, D. W., 887
Robinson, M., 894
Root, G. T., 243
Rosomoff, H. L., 704
Ross, W. D., 577
Rousselot, L. M., 31, 685
Rubenstein, A. S., 116
Rubin, L. R., 880
Ruge, D., 918
Ryan, A. J., 325

Sakson, J. A., 693
Sampson, J. J., 211
Scanlon, E. F., 851
Schilling, J. A., 3
Schneewind, J. H., 544
Schultz, L. W., 839, 921
Schwartz, S. I., 20
Segel, A. L., 105
Shaeffer, J. R., 573
Shafiroff, B. G. P., 34
Shann, H., 25
Shidler, F. P., 152
Shulman, K., 704
Sills, A. H., 787
Simmons, J. C. H., 379
Sinkler, W. H., 623
Sloan, R. F., 217
Slocum, D. B., 394
Smith, A. E., 830
Smith, A. M., 606
Smith, G. K., 236
Smith, M. C., 753
Smith, S. S., 653
Spickard, W. B., 196
Stack, J. K., 569
Stafford, C. E., 271
Staley, C. J., 851
Stare, F. J., 343
Steelquist, J. H., 257
Stone, C. S., Jr., 133, 304
Sweetman, W. R., 746
Swerdlow, M., 858

Takaro, T., 617
Thompson, L. R., 625
Thorndike, A., 316
Trewin, M. L., 758
Trota, J., 907
Tuohy, C. E. M., Jr., 160

Uhley, H. N., 211
Urist, M. R., 423

Vannix, R., 271
Vazirani, S. J., 839, 869, 921
Vermooten, V., 457

Wade, P. A., 526
Wagner, C. L., 265
Walden, R. H., 880
Weinberg, J. A., 165
Weinstein, M., 713
Weir, G. J., Jr., 373
Wetzel, N., 800
Wheelock, M. C., 907
Wilhelm, M. C., 606
Williams, R. D., 447
Winterscheid, L. C., 649
Wise, R. A., 746
Wolfman, E. F., Jr., 4
Woodward, F. D., 521
Woughter, H. W., 550
Wynn, S. K., 811

Zollinger, R. W., 728

Subject Index, Volume 98

(E) = Editorial (DC) = Diagnostic Corner (CAC) = Case Analysis Clinic

Abdomen
  acute problem of, in elderly male (CAC), 637
  and thorax, athletic injuries to, 447
Accidents
  and sagacity (E), 649
  motor vehicle, among Armed Forces personnel, 573
Acromioclavicular joint, dislocations of, 423
Adenoma
  gastric, clinicopathologic study of, 223
  villous, and electrolyte depletion (CAC), 772
  of rectosigmoid, hyponatremia due to, 99
Ambulance, transportation of injured in, 530
Ameloblastomas, new treatment of, 839
American Medical Association committee on injury in sports, 325
Anastomoses of gastrointestinal tract, clamp for, 728
Aneurysm, false, in femoral arterial homograft, 753
Ankle fractures
  and dislocations treated by open reduction, 136
  and ligament injuries, 477
Anoscope, rotatable, lighted, for anorectal evaluation, 730
Antibiotics, evaluation of suture materials treated with, 695
Aorta
  absence of arch of, 265
  upper thoracic, experimental replacement of segments of, 617
  valve of, apparatus for determination of gradients across, during surgery, 9
Appendicitis
  analysis of downward trend of, 702
  benign cecal lesions associated with, 598
Artery
  hypogastric, bilateral ligation of, 34
  inferior mesenteric, acute occlusion of, 271
Arthroplasty, cartilage block, for correction of temporomandibular joint disturbances, 787
Atelectasis, rebreathing tube for, 20
Athletic injuries
  muscle function in, 353
  to abdomen and thorax, 447
  to elbow, forearm, wrist and hand, 432
  to face, 390
  to genitourinary tract, 457
  to head and neck, initial management of, 379
  to pelvis, hip and thigh, 451
  to shoulder, mechanics of, 394
Athletic injuries
  to shoulder region, 401
Athletics
  and nutrition, 343
  and organized medicine, 325
  modern, place of trainer in, 337
Atomic bomb exposure, original signs and symptoms in patients surviving five years after, 12
Atonia, gastric, after vagotomy, 612
Automobile accidents
  neurological, neurosurgical and psychiatric considerations in prevention and treatment of, 577
  responsibility of medical profession to victims of, 526

Baseball players, elbow and shoulder lesions of, 484
Biopsy with delayed radical mastectomy for carcinoma of breast, 184
Bone involvement in maxillofacial cancer, 898
Book reviews
  Diseases of the Esophagus. J. Terracol and Richard H. Sweet. W. B. Saunders Co., 938
  Ideals in Medicine. Edited by V. Edmunds. The Tyndale Press, 132
  Operative Surgery. Vol. VI, Orthopedic Surgery. Edited by C. Rob. Butterworth & Co., Ltd., 782
  Surgery of the Chest. J. Johnson. Year Book Publishers, Inc., 132
  The Atlas of Technics in Surgery. J. L. Madden. Appleton-Century-Crofts, Inc., 782
  The Roosevelt Hospital 1871–1957. Committee on History of Roosevelt Hospital, 132
  Tracheotomy: A Clinical and Experimental Study. Thomas G. Nelson. William & Wilkins Co., 938
Bowel, sterilization of, in infants and children, 603
Boxing injuries, 509
Brain, experimental injury to, and effect of hypothermia, 704
Breast
  cancer of, in Rockford, Illinois, 653
  carcinoma of, biopsy with delayed radical mastectomy for, 184
  Paget's disease of, in man, 623
Brooks, Dr. Barney, 706
Burns
  acute thermal, of face, 923
  chart for recording data in treatment of, 693

Burns
chemical, 928
electrical, of mouth, 921

Cancer
intraoral, surgical management of, 844
maxillofacial, bone involvement in, 898
of breast in Rockford, Illinois, 653
of head and neck, 915
treated with betatron electron beam, 847
of thyroid, a twenty-year follow-up of, 190
oral, in women, 869
Carcinoma
of breast, biopsy with delayed radical mastectomy for, 184
squamous cell, of anterior part of tongue, 677
Case analysis clinic
Abdomen, acute condition of, in elderly male, 637
Adenoma, villous, with electrolyte depletion, 772
Cushing's syndrome, 775
Pneumothorax, 12
Cecum
benign lesions of, associated with appendicitis, 598
volvulus of, 175
Cesarean section
management of placenta in, 41
postmortem, 758
Chemical burns, 928
Cholecystitis, acute, in a municipal charity hospital, 283
Chondromalacia of fabella, 760
Coarctation, absent aortic arch and other variants of, 265
Colitis, ulcerative, surgical treatment of, 165
Colon, ascending, volvulus of, 175
Coloproctectomy, single-stage, compared with other procedures for treating ulcerative colitis, 165
Common duct, indications for exploration of, 606
Contusion of left kidney (DC), 764
Court cases, surgery, 120, 635, 762
Craniocerebral injury, neurological evaluation of, 918
Cushing's syndrome, surgical management of (CAC), 775
Cystic duct remnant, 296
Cysts
dermoid and bilateral, of ovaries, 739
intradiaphragmatic, removal of, 95
primary retroperitoneal pseudomucinous, 750

Debricin ficus protease, indications for and application of, 685
Débridement
enzymatic, with bovine fibrinolysin, 4
use of Debricin ficus protease for, 685
Diagnostic corner
Contusion of left kidney, 764
Dislocation, forward, of carpal lunate bone, 642
Hematoma of spleen, 768
Monteggia fracture-dislocation, 122
Diaphragm, removal of cyst within, 95
Diet for athletes, 343
Discs, ruptured cervical, vertebral body fusion for, 722
Dislocation
and fracture of ankle, open reduction of, 136
forward, of carpal lunate bone (DC), 642
of acromioclavicular joint, 423
Driver education program in Flint, Michigan, 550
Duodenum, mobilization of, in gastrectomy, 713
Dysphagia and esophageal defect caused by ruptured anterior nucleus pulposus, 631

Editorials
Accidents and sagacity, 649
Introduction to symposia on
maxillofacial surgery, 783
medical aspects of traffic safety and related injuries, 517
sports injuries, 315
Problems in management of perforated peptic ulcer, 1
Pulmonary hypertension and cardiac surgery, 651
Responsibility (Presidential Address, Pacific Coast Surgical Association), 133
Surgical technic, 3
Elbow
and shoulder, lesions of, in baseball players, 484
forearm, wrist and hand, athletic injuries to, 432
Emergency room, requirements for, 544
Enzymes, débridement of ulcerating wounds with, 4
Esophagitis
and stricture caused by nasogastric tube, 116
reflux, complicated by hemorrhage, 657
Eye, injuries to, 384

Fabella, chondromalacia of, 760
Face
acute thermal burns of, 923
injuries to, in sports, 390
Fibrinolysin, bovine, enzymatic débridement with, 4
Football equipment, protective, 363
Forearm, elbow, wrist and hand, athletic injuries to, 432
Fractures
and dislocations of ankle, open reduction of, 136
and ligament injuries of ankle, 477
of tibial shaft, conservative treatment of, 593

G-27202, evaluation of, for reducing inflammation, 31
Gallbladder
effect of pancreatic secretions on, in absence of bile, 290
macroscopically non-pathologic, 276
Gastrectomy, duodenal mobilization in, 713
Gastric adenomas, clinicopathologic study of, 223
Gastritis, giant hypertrophic, 584
Genitourinary tract, sports injuries to, 457

Hand, elbow, forearm and wrist, athletic injuries to, 432

Head and neck
athletic injuries to, 379
cancer of, 915
treated with betatron electron beam, 847
malignancies of, neurosurgery for control of pain in, 800
malignant tumors of, 858
Headgear, protective, engineering research on, 368
Hematoma
compression of mediastinum by, 735
subcapsular encysted, of spleen (DC), 768
Hemorrhage and reflux esophagitis, 657
Hernia
hiatal, with carcinoma of transverse colon, 758
umbilical, observations on imbrication for repair of, 236
Hip, pelvis and thigh, athletic injuries to, 451
Hirschsprung's disease with extensive aganglionic segments, 248
"Hocker" valve used in tracheotomy tubes, 733
Homograft
abdominal aortic, rupture of, 746
femoral arterial, false aneurysm in, 753
Homotransplants, mammalian, of skin, 217
Hypertension, pulmonary, and cardiac surgery (E), 651
Hypnosis, medical, in maxillofacial and plastic surgery, 826
Hyponatremia due to villous adenoma of rectosigmoid, 99
Hypoplasia of right hepatic lobe, 628
Hypothermia, effect of, on experimental injury to brain, 704
Hysterectomy, vaginal, simplified technic of, 25

Inflammation, evaluation of new agent for reduction of, 31
Injuries
and deaths, automobile, medical and civic responsibilities of physician in preventing, 521
athletic
in adolescents, 332
muscle function in, 353
to abdomen and thorax, 447
to elbow, forearm, wrist and hand, 432
to genitourinary tract, 457
to head and neck, 379
to pelvis, hip and thigh, 451
to shoulder region, 401
craniocerebral, neurological evaluation of, 918
facial, in sports, 390
from boxing, 509
ligament, and fractures of ankle, 477
skiing, 493
sports, frequency and nature of, 316
sports, symposium on, 315–516
to brain, experimental, effect of hypothermia on, 704
to eye, 384
to knee, 463
to shoulder in sports, 394

"Joint Action Committee" and accident prevention, 583

Knee, injuries to, 463

Leiomyosarcoma of rectum, 105
Lesions of elbow and shoulder in baseball players, 484
Ligaments
injury to and fracture of ankle, 477
torn, experimental investigation of repair of, 373
Liver, effect on, in rabbits from ligation of hepatic artery, 44
Liver, hypoplasia of right hepatic lobe of, 628
Lymph flow, measurement of, from right duct in dog, 211

Malignancies of head and neck, neurosurgery for control of pain in, 800
Mandible
osteoradionecrosis of, 887
prognathism of, corrected by ostectomy of ramus, 830
corrected by osteotomies of rami, 894
Mastectomy, delayed radical, with biopsy, for carcinoma of breast, 184
Maxillofacial
and plastic surgery, medical hypnosis in, 826
cancer, bone involvement in, 898
surgery, symposium on, 783–937
trauma and frontal sinus, 796
Mediastinum, compression of, by hematoma, 735
Medical-legal considerations, 875
Mesentery, acute occlusion of inferior artery of, 271
Miller-Abbott tube intubation, technic and indications for, 160
Monteggia fracture-dislocation (DC), 122
Motor vehicle accidents in Armed Forces, 573
Mouth, electrical burns of, 921
Mucosa, buccal, disorders of, 805
Mucous membrane, oral, etiology of lesions of, 809
Muscle function in athletic injury, 353
Musculoskeletal cripples, as drivers, and relation to traffic accidents, 569
Myasthenia gravis, present status of thymectomy in, 196

Neck
and head
athletic injuries to, 379
cancer of, 915
malignancies of, neurosurgery for control of pain in, 800
malignant tumors of, 858
bilateral radical dissection of, 851
Neoplasms of salivary glands, pathologic features of, 907
Neurosurgery for control of pain in malignancies of head and neck, 800

Nose, partial reconstruction of, 784
Nucleus pulposus, ruptured anterior, causing esophageal defect and dysphagia, 631
Nutrition and athletics, 343

Ostectomy of ramus to correct mandibular prognathism, 830
Osteoarthritis of spine, 683
Osteoradionecrosis of mandible, 887
Osteotomy of ramus for correction of mandibular prognathism, 894
Our surgical heritage
  Bell, John, 648
  Dupuytren, Baron Guillaume, 781
  Larrey, Baron Dominique Jean, 130
  McDowell, Ephraim, 646
  Mott, Valentine, 128
  Warren, John Collins, 779
Ovaries, bilateral dermoid cysts of, 739

Pacific Coast Surgical Association, papers of, 133–314
Paget's disease of male breast, 623
Palate
  cleft, bone-flap method in surgery for, 811
    vomar flap technic for correction of, 821
Pancreatitis, chronic, surgical management of, 304
Pectus excavatum, 664
Pelvis, hip and thigh, athletic injuries to, 451
Penicillin and streptomycin, influence of in rabbits after ligation of hepatic artery, 44
Peptic ulcer, perforated, problems in management of (E), 1
Peritonitis, caused by surgical glove starch powder, treated with steroids, 111
Physical fitness for sports, 328
Placenta, management of, in cesarean section, 41
Plastic and maxillofacial surgery, medical hypnosis in, 826
Plethysmographs, electronic segmental and digital, used in arterial surgery, 257
Pneumothorax (CAC), 126
Pregnancy, abdominal, at term, 625
Presidential address, Pacific Coast Surgical Association, 133
Prognathism
  mandibular, corrected by ostectomy of ramus, 830
    corrected by osteotomies of rami, 894
Pseudomyxoma peritonaei, 229

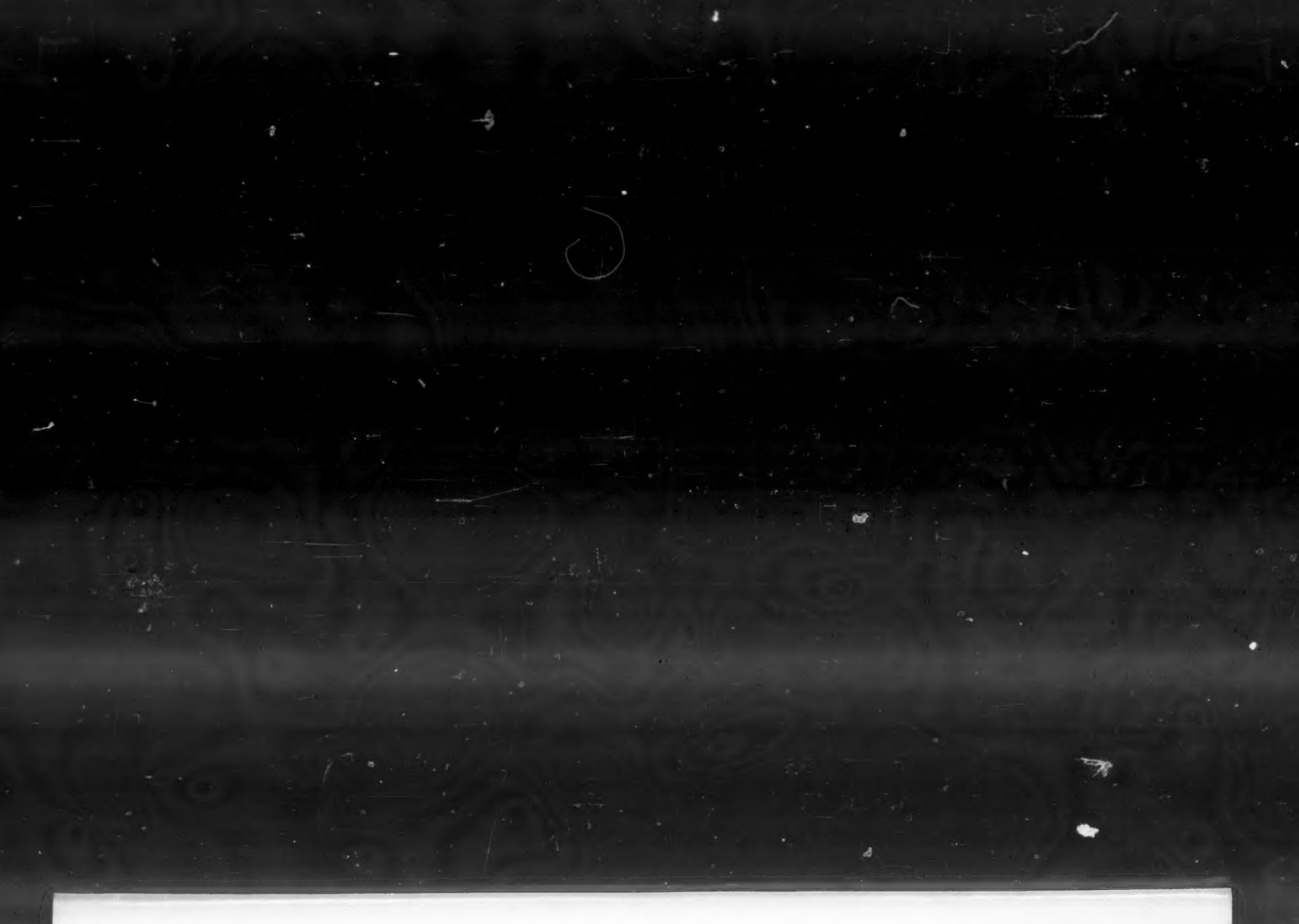
Radiation therapy for treatment of tumors of salivary gland, 912
Ramus, ostectomy of, to correct mandibular prognathism, 830
Rectosigmoid, villous adenoma of, with hyponatremia, 99
Rectum
  carcinoid tumors of, 243
  leiomyosarcoma of, 105
Retroperitoneum, primary pseudomucinous cyst of, 750
Rocket, home-made, management of patient with abdominal injury from, 91
Rupture
  of abdominal aortic homograft, 746
  of cervical discs, vertebral body fusion for, 722

Salivary gland
  major, tumors of, 904
  neoplasms of, 907
  tumors of, treated with radiation therapy, 912
Shoulder
  and elbow, lesions of, in baseball players, 484
  injuries to, in sports, 394
  region, athletic injuries to, 401
Sinus, frontal, and maxillofacial trauma, 796
Situs inversus totalis, 107
Ski injuries, 493
Skin
  diving, rules of behavior for, 506
  mammalian homotransplants of, 217
Spine, osteoarthritis of, 683
Sports
  injuries, frequency and nature of, 316
    symposium on, 315–516
  physical fitness for, 328
Steroids, treatment of peritonitis with, 111
Streptomycin and penicillin, influence of, in rabbits after ligation of hepatic artery, 44
Submaxillary duct, penetration of, by broken thermometer bulb, 743
Surgery
  arterial, and use of electronic segmental and digital plethysmographs, 257
  cardiac, and pulmonary hypertension (E), 651
  court cases, 120, 635, 762
  determination of pressure gradients across aortic valve during, 9
  for chronic pancreatitis, 304
  for cleft muscular velopharynx, 816
  for cleft palate, bone-flap method in, 811
  for intradiaphragmatic cyst, 95
  for intraoral cancer, 844
  in rocket era, 91
  maxillofacial and plastic, medical hypnosis in, 826
  maxillofacial, symposium on, 783–937
  technic of (E), 3
  wounds from, routine culture of, 152
Suture materials treated with antibiotics, evaluation of, 695
Symposia on
  maxillofacial surgery, 783–937
  medical aspects of traffic safety and related injuries, 517–583
  sports injuries, 315–516

Thigh, pelvis and hip, athletic injuries to, 451
Thorax and abdomen, athletic injuries to, 447
Thymectomy in myasthenia gravis, 196
Thymomas, current concepts of, 202

Thyroid, cancer of, 190
Tibia, shaft of, conservative treatment of fractures of, 593
Tissue, transplantation of, 55
Tongue, anterior part of, squamous cell carcinoma of, 677
Tracheostomy, elective, in infants and children, 880
Traffic
  casualties, preliminary management of, 539
  safety and related injuries, symposium on, 517–583
  safety, promotion of, by automobile industry, 555
Trainer, place of, in modern athletics, 337
Transplant of tissues, 55
Transportation of injured, 534
Trauma
  and "joint action," 583
  and society, need for accident prevention programs for, 559
  maxillofacial, and frontal sinus, 796
  teaching of, in medical schools, 566
  treatment of, need for resident training in, 519
Tumors
  carcinoid, of rectum, 243
Tumors
  malignant, of head and neck, 858
  of major salivary glands, 904
  of salivary gland, radiation therapy for, 912

Ulcer
  obstructing, gastric atonia and delayed gastric emptying after vagotomy for, 612
  perforated peptic, problems in management of (E), 1
Umbilicus, hernia of, repaired by imbrication, 236
  preservation of dimple of, after hernial repair, 236

Vagina, hysterectomy through, 25
Vagotomy for obstructing ulcer, gastric atonia and delayed gastric emptying after, 612
Velopharynx, cleft muscular, surgical management of, 816
Vertebrae, fusion of bodies of, for ruptured cervical discs, 722
Volvulus of cecum or ascending colon, 175

Wounds, surgical, routine culture of, 152
Wrist, elbow, forearm and hand, athletic injuries to, 432